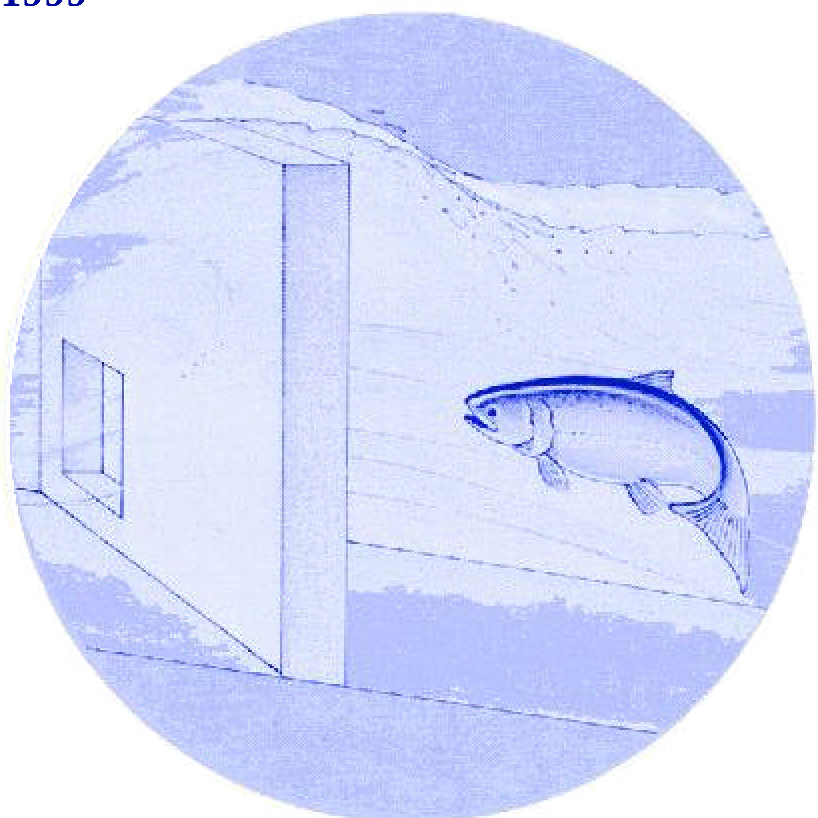
Escapement Monitoring of Adult Chinook Salmon in the Secesh River and Lake Creek, Idaho

Annual Report
1999



DOE/BP-30423-7

April 2001

This Document should be cited as follows:

Faurot, Dave, Paul Kucera, ''Escapement Monitoring of Adult Chinook Salmon in the Secesh River and Lake Creek, Idaho'', Project No. 1997-03000, 82 electronic pages, (BPA Report DOE/BP-30423-7)

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

Escapement Monitoring of Adult Chinook Salmon in the Secesh River and Lake Creek, Idaho, 1999

1999 Annual Report

Prepared by:

Dave Faurot and Paul A. Kucera

Nez Perce Tribe
Department of Fisheries Resources Management
Lapwai, ID 83540

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Environment, Fish and Wildlife
P.O. Box 3621
Portland, OR 97208-3621

Project Number 00000333-000331
Contract Number 97 AM 30423
Task Order Number 97 AT 34687

April, 2001

ABSTRACT

Underwater time-lapse video technology was used to monitor adult spring and summer chinook salmon abundance in spawning areas in Lake Creek and the Secesh River, Idaho, in 1999. This technique is a passive methodology that does not trap or handle this Endangered Species Act listed species. This was the third year of testing the remote application of this methodology in the Secesh River drainage. Secesh River chinook salmon represent a wild salmon spawning aggregate that has not been directly supplemented with hatchery fish.

Adult chinook salmon spawner abundance was estimated in Lake Creek with the remote time-lapse video application. Adult spawner escapement into Lake Creek in 1999 was 67 salmon. Significant upstream and downstream spawner movement affected the ability to determine the number of fish that contributed to the spawning population. The first passage on Lake Creek was recorded on July 11, two days after installation of the fish counting station. Peak net upstream adult movement occurred at the Lake Creek site on July 20, peak of total movement activity was August 19 with the last fish observed on August 26. A minimum of 133 adult chinook salmon migrated upstream past the Secesh River fish counting station to spawning areas in the Secesh River drainage. The first upstream migrating adult chinook salmon passed the Secesh River site prior to the July 15 installation of the fish counting station. Peak net upstream adult movement at the Secesh River site occurred July 19, peak of total movement was August 15, 17 and 18 and the last fish passed on September 10. Migrating salmon in the Secesh River and Lake Creek exhibited two behaviorally distinct segments of fish movement. Mainly upstream only, movement characterized the first segment. The second segment consisted of upstream and downstream movement with very little net upstream movement. Estimated abundance was compared to single and multiple-pass redd count surveys within the drainage. There were differences between the two methodologies. The fish counting stations did not impede salmon movements, nor was spawning displaced downstream. Fish moved freely upstream and downstream through the fish counting structures. Fish movement was greatest between the period of 10:00 p. m. and 4:00 a. m. There appeared to be a segment of “nomadic” males that moved into and out of the spawning area, apparently seeking other mates to spawn with.

This methodology has the potential to provide more consistent and accurate salmon spawner abundance information than single-pass and multiple-pass spawning ground surveys. Accurate adult escapement information would allow managers to determine if recovery actions benefited listed chinook salmon in tributary streams.

TABLE OF CONTENTS

ABSTRACT ii

TABLE OF CONTENTS iii

LIST OF FIGURES iv

LIST OF TABLES v

ACKNOWLEDGMENTS 6

INTRODUCTION 1

DESCRIPTION OF PROJECT AREA 3

METHODS AND MATERIALS 4

TIMING AND ABUNDANCE 4
Equipment 4
Procedure 7
MONITORING AND EVALUATION 9
DESIGN AND PLACEMENT CRITERIA 10

RESULTS AND DISCUSSION 10

MIGRATION TIMING AND ABUNDANCE 10
Lake Creek 10
Secesh River 15
COMPARISON TO REDD COUNTS 18
MOVEMENT 20
Diel Movement 20
Upstream/Downstream Movement 21
DESIGN AND PLACEMENT CRITERIA 22
MONITORING AND EVALUATION 23
FORK LENGTHS 25
TEMPERATURE 25

RECOMMENDATIONS 27

LITERATURE CITED 28

APPENDIX A 32

APPENDIX B 57

APPENDIX C 72

LIST OF FIGURES

Figure 1. Map of the Secesh River drainage and locations of the fish counting stations (*denotes fish counting station). 5

Figure 2. Escapement monitoring project area for snorkel and visual bank observations in Lake Creek in 1999. 6

Figure 3. Escapement monitoring project area for snorkel and visual bank observations in the Secesh River in 1999. 6

Figure 4. Artist's rendition of the underwater video escapement monitoring fish counting station. 7

Figure 5. Underwater video photograph of a male chinook salmon migrating through the fish counting chamber. 8

Figure 6. Net upstream spawning migration of adult spring and summer chinook salmon migrating through the Lake Creek fish counting station in 1999. 13

Figure 7. Cumulative frequency of adult spring and summer chinook salmon spawner escapement migrating through the Lake Creek fish counting station in 1998 and 1999. 14

Figure 8. Daily net upstream and total (upstream and downstream) movements of adult spring and summer chinook salmon through the Lake Creek fish counting station in 1999. 14

Figure 9. Net upstream spawner migration of adult spring and summer chinook salmon through the Secesh River fish counting station in 1999. 16

Figure 10. Cumulative number of adult spring and summer chinook salmon spawner escapement migrating through the Secesh River fish counting station in 1999. 17

Figure 11. Daily net upstream and total (upstream and downstream) movements of adult spring and summer chinook salmon through the Secesh River fish counting station in 1999. 17

Figure 12. Diel timing of net upstream movements of adult spring and summer chinook salmon through the Lake Creek and Secesh River fish counting stations in 1999. 21

Figure 13. Daily maximum and minimum temperatures and chinook salmon net upstream escapement through the Secesh River fish counting station in 1999. 26

LIST OF TABLES

Table 1. Summary of major chinook salmon escapement dates in Lake Creek and the Secesh River, 1998 and 1999. 11

Table 2. Correction of adult spring and summer chinook salmon spawner escapement abundance estimate at the Lake Creek fish counting station in 1999. 12

Table 3. Fish per redd in Lake Creek and the Secesh River compared to data from the Imnaha River and Lookingglass Creek. 20

Table 4. Potential sources of error in underwater video abundance methodology. 20

Table 5. Spring and summer chinook salmon redd counts in the Secesh River and Lake Creek index areas, and in the Secesh River from the fish counting station downstream to the canyon, 1992 to 1999. 24

Table 6. Effects of the Secesh River and Lake Creek fish counting stations on adult spring and summer chinook salmon movement, 1997 to 1999. 25

Table 7. Water temperatures in the vicinity of Chinook Campground, Secesh River, and adult spring and summer chinook salmon activity through the Secesh River fish counting station, 1998 and 1999. 26

Table A-1. Run timing and direction of adult spring and summer chinook salmon passing the escapement monitoring fish counting station in the Secesh River in 1999. 32

Table A-2. Diel movements of adult spring and summer chinook salmon through the Secesh River fish counting station, by hour, in 1999. 56

Table B-1. Run timing and direction of adult spring and summer chinook salmon passing the escapement monitoring fish counting station in Lake Creek in 1999. 57

Table B-2. Diel movements of adult spring and summer chinook salmon passing through the Lake Creek fish counting station, by hour, in 1999. 71

Table C-1. Dates of net upstream migration and total movements of adult spring and summer chinook salmon through the Secesh River and Lake Creek fish counting stations in 1999. ..72

ACKNOWLEDGMENTS

The Bonneville Power Administration provided funding for this project. We would like to thank Tom Bumstead for engineering design and structure placement, and Nez Perce Department of Fisheries Resources Management personnel Monika Adam, Luis Arenas, Clint Chandler, Audrick Chapman, Sam Davis, Zachary Penney, David Steffy, Levi Sublett and Toby Tabor for project operations and structure placement. John Hintz of the Nez Perce Tribe furnished the map of the Secesh River drainage. Special thanks to Steve Kammeyer, Gene McPherson, and Joel Patterson from the McCall Fish Hatchery for assistance in determining the sex of adult chinook salmon from video tapes. We thank the U.S. Forest Service for the use of Chinook Campground facilities to station our crew and trailer for the duration of the project. We also appreciate the Nez Perce Tribe for administration of this project.

INTRODUCTION

Salmon recovery within the Columbia River basin has become a focal point in the Pacific Northwest. Congress directed an independent scientific review of the Northwest Power Planning Council's (NWPPC) Fish and Wildlife Program activities because earlier programs were criticized as being a list of separate unrelated measures without any underlying scientific foundation (**Citation)**. Large amounts of time, effort and funding have been spent to improve fish passage conditions, augment flows, enhance and restore habitat, constrain harvest and use hatchery supplementation to increase salmon populations. Despite these efforts, salmon populations have continued to decline. The National Marine Fisheries Service has issued a Biological Opinion for the operation of the federal Columbia River power system (NMFS 2000) that attempts to define criteria/population levels that would ensure continued existence of critical fish stocks. Recovery goals are defined in terms of numbers of naturally spawning adult salmon returning to spawning areas. Therefore, accurate determination of adult salmon spawner abundance is of utmost importance to fisheries managers. Within the South Fork Salmon River, Secesh River spring and summer chinook salmon (*Oncorhynchus tshawytscha*) represent a wild salmon spawning aggregate. An analysis of Secesh River chinook salmon annual redd count data from 1957 to 1995 described a population trend in significant decline ($p<0.01$) (Kucera and Blenden 1999). The Secesh River is currently used as a control system for the Idaho Salmon Supplementation studies (Bowles and Leitzinger 1991).

Spring and summer chinook salmon in the entire Snake River basin, including the Secesh River, are listed as threatened under the Endangered Species Act (ESA) (NMFS 1992). The Biological Opinion for operation of the federal Columbia River power system (NMFS 2000) recommended that accurate assessment of spawner escapement of listed Evolutionary Significant Units (ESU) are required for determining the characteristics, viability, recovery status, and delisting of ESU's under ESA. NMFS (2000) further defined the degree to which species-level biological requirements must be met: "At the species level, NMFS considers that the biological requirements for survival, with an adequate potential for recovery, are met when there is a high likelihood that the species population will remain above critical escapement thresholds over a sufficiently long period of time. The particular thresholds, recovery levels, and time periods must be selected depending upon the characteristics and circumstances of each salmon species under consultation (NMFS 2000)". The recovery metric for listed ESUs is the likelihood that the 8-year geometric mean abundance of natural spawners in a population will be equal to or greater than an identified recovery abundance level (NMFS 2000).

The NMFS recommended characterizing populations by abundance/productivity, diversity (viability), spatial structure, and habitat capacity (NMFS 2000), most of which rely on some quantitative measure of adult abundance. Adult abundance determination is also a necessary component of proposed short-term stock performance measures that focus on life history stages (NMFS 2000). The Validation Monitoring Panel (Botkin et al. 2000) provided a science-based analysis for monitoring of salmon for conservation plans. The panel also identified the need for accurate adult salmon abundance information in relation to conservation and restoration plans.

Determination of adult spawner abundance information is a critical aspect of a viable population management strategy (Foose et al. 1995, Botkin 2000) which is recognized within the scientific community and in recovery planning efforts (NMFS 2000). Currently, there is no quantitative information available to determine spawner abundance of spring and summer chinook salmon in tributary streams of the Snake River basin. Therefore, we can not measure the effectiveness of conservation actions for a threatened species (Botkin et al. 2000). Quantifying adult salmon spawner abundance will provide a direct measurement of benefits of the Northwest Power Planning Council's Fish and Wildlife Program projects (funded by BPA) and efforts of recovery alternatives.

Traditional chinook salmon redd count surveys conducted in Idaho since the mid 1950's have relied upon one-time counts at the peak of spawning as an index of relative abundance over time (trend) (Elms-Cockrum 1999). Recent surveys on some streams have used multiple ground counts of spawning activities for more accurate assessment of salmon redds (Kucera 1987, Cowley and Kucera 1989, Kucera and Banach 1991, Kucera and Blenden 1993, Kucera and Blenden 1999). Expansion of redd counts to spawner numbers are influenced by measurement error and uncertainty of assumptions regarding estimates of fish per redd, relative numbers in surveyed and unsurveyed areas, prespawning mortality rates, age composition, and hatchery fish composition (Beamesderfer et al. 1999). Neither of these provides accurate spawner numbers.

Existing adult weirs are another potential source of adult spawner abundance information. The primary purpose of permanent and temporary adult weirs is for hatchery broodstock collection. Adult broodstock collection weirs are not sited for monitoring adult spawner abundance in streams. They most often provide either a minimum spawner estimate or a mark recapture spawner estimate derived from marked fish carcass recovery from spawning grounds. These estimates are also affected by measurement error and uncertainty of assumptions. Better methods and techniques are required.

This investigation began in 1991 with planning and conceptual engineering design of an adult fish counting facility on the lower Secesh River (Fish Management Consultants 1991) funded through the Pacific Salmon Commission. Listing of the species under the Endangered Species Act in 1992, and concerns with a permanent facility and handling of fish, prompted the search for a site where temporary facilities could be used. Preliminary design work followed in 1994 (River Masters Engineering 1994). The Nez Perce Tribe has worked cooperatively with the Idaho Department of Fish and Game (IDFG) and the U.S. Forest Service (USFS) in the planning and developmental stages of this project.

New technology is available that may improve the accuracy of salmon spawner escapement estimates. We installed and test operated a temporary fish counting station on private land in the Secesh River, in 1997 (Faurot and Kucera 1999), to evaluate the use of underwater time-lapse video technology to determine abundance and timing of adult escapement into wild spring and summer chinook salmon production areas. Time-lapse video has been used before, primarily to enumerate adults at fish counting/viewing windows at hydroelectric projects (Hatch et al. 1994a, 1994b). In some cases, cameras have been submerged in fish ladders to evaluate fish passage. Limited studies have used cameras underwater in a natural setting **(citation)**. Holubetz and Leth

(1996) experimentally operated a similar natural stream, remote video recorder system on Running Creek, in the headwaters of the Selway River.

As adult salmon migrated upstream through the counting chambers, a photograph of them was taken via the underwater video camera. The structures allowed both upstream and downstream fish movement. Fish were not trapped, handled or held in any manner. In 1998, the fish counting station on the Secesh River was moved 1,000 meters downstream from the 1997 site to a better location on U. S. Forest Service land to include more spawning area. A second fish counting station was installed in 1998, on Lake Creek, a headwater tributary of the Secesh River (Faurot et al. 2000). Lake Creek is a smaller stream, is easier to work in, and is assumed to be a separate spawning aggregate of chinook salmon. Both fish counting stations were operated in 1999. Information collected from this project will allow comparison to redd count survey data to assess if redd count information provides reliable indices of adult salmon escapement.

The goal of this project is to accurately assess the spring and summer chinook salmon spawning migration in the Secesh River and Lake Creek drainages. This is a goal of the Nez Perce Tribe for all anadromous waters within their cede territory. The goal emphasizes collection of accurate spawner abundance information. Presently, an index of relative abundance is estimated from index area or intensive redd count data in the Secesh River and Lake Creek.

The objectives of the study were to:

1) Accurately determine adult spring and summer chinook salmon spawner abundance in the Secesh River and Lake Creek on an annual basis.
2) Determine the timing of adult spring and summer chinook salmon spawning migration into the Secesh River and Lake Creek drainages.
3) Determine the accuracy of redd count methodology compared to the underwater video escapement enumeration technique.

DESCRIPTION OF PROJECT AREA

The Secesh River, in west central Idaho, is formed at the junction of Summit and Lake creeks, and traverses 45 km to the southeast where it flows into the South Fork Salmon River (Figure 1). Headwaters of Lake Creek are in the mountains above Burgdorf at an elevation of 2,417 m. Elevation drops to 1,838 m where Lake Creek joins Summit Creek to form the Secesh River. Elevation of the Secesh River then drops to 1,110 m where it flows into the South Fork Salmon River. Average gradient in the vicinity of the projects is 0.5 percent. The Lake Creek project area was located from the mouth of Lake Creek upstream 300 m (Figure 2). The fish counting station was situated with 100 m of the project area downstream of the facility and 200 m of the project area upstream of the facility. The Secesh River project area was located 30 km upstream from the South Fork Salmon River at the U. S. Forest Service's Chinook Campground. The project area, for monitoring and evaluation purposes, was approximately 367 m (Figure 3). The fish counting station was initially located 233 m upstream of the lower project boundary.

The Secesh River has minimal chinook salmon spawning habitat from the mouth upstream 27.5 km to the upper end of the canyon area. About 2.5 km of limited spawning habitat is available from the upper end of the canyon, upstream to the fish counting station. The major chinook salmon spawning area is located upstream of the fish counting station in Secesh Meadows. There is spawning habitat available in lower Grouse and Summit creeks. A mixture of good and scattered spawning habitat exists in Lake Creek from Burgdorf Meadows up to Willow Creek. Additional spawning area exists upstream of Willow Creek. The Nez Perce Tribe has conducted annual chinook salmon multiple ground count surveys in the Secesh River and Lake Creek since 1987.

METHODS AND MATERIALS

TIMING AND ABUNDANCE

Equipment

Temporary fish counting stations were installed in Lake Creek and the Secesh River to accurately determine adult escapement into wild spring and summer chinook salmon production areas. The structure included tripod supported upstream and downstream guide fences with a video equipped counting chamber (Figure 4). Fish guiding fences installed between a 30 to 45 degree angle to the bank directed upstream or downstream migrating chinook salmon through a fish counting chamber. The entrance to the 1.22 m long counting chamber was 0.86 m wide and 0.72 m high. Underwater time-lapse video cameras mounted to the side of the fish counting chambers took photographs of the fish as they passed. An adjustable platform allowed the cameras to be moved up, down, forward, and/or backward as the water level fluctuated to ensure the entire field of view in the counting chambers was recorded on the tape. The counting chambers were located in the thalweg, which appeared to be the preferred migration route. Upstream and downstream migrating adults were able to move freely into and through the counting chambers. Fish were not trapped, handled or held at any time.

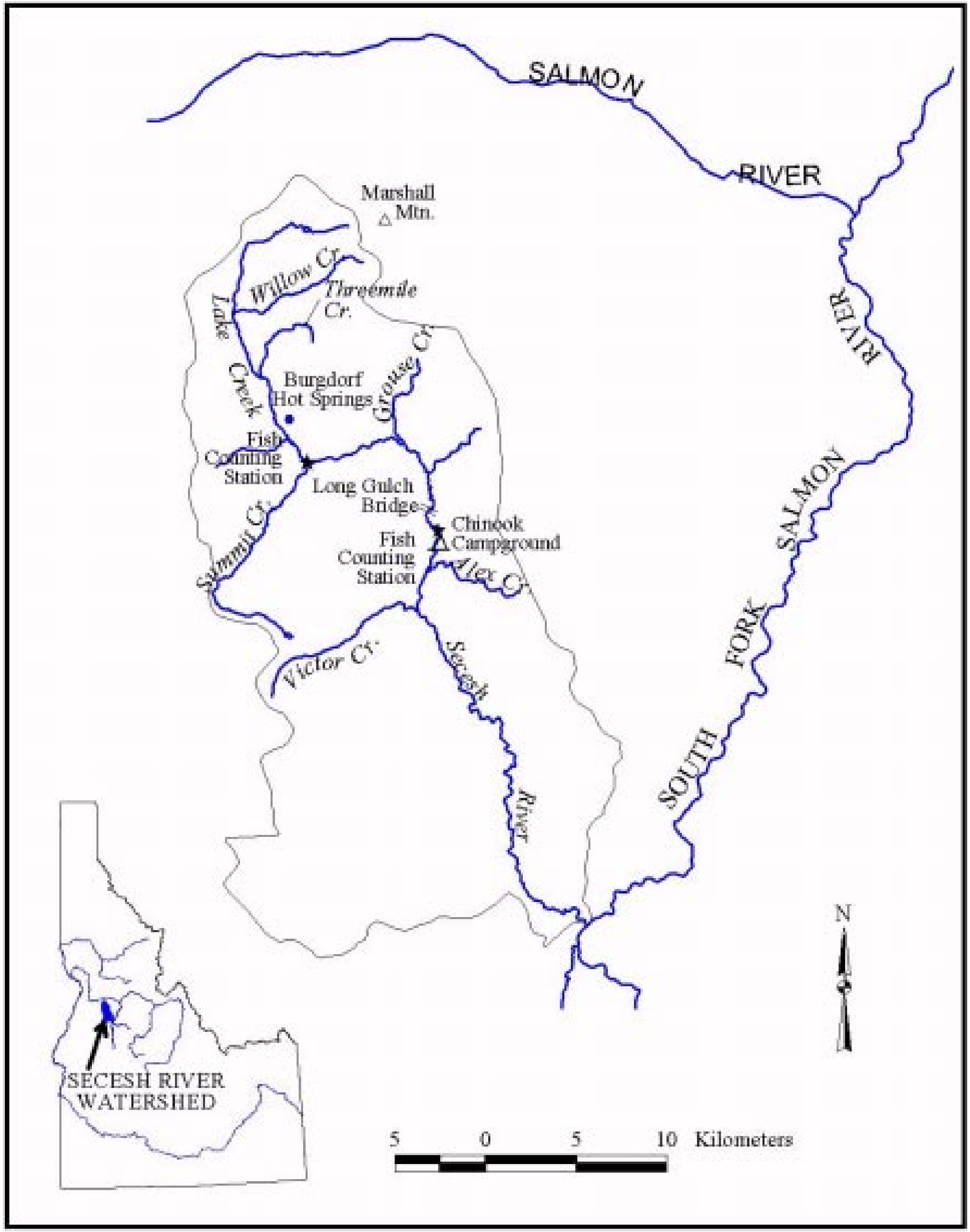


Figure 1. Map of the Secesh River drainage and locations of the fish counting stations (*denotes fish counting station).

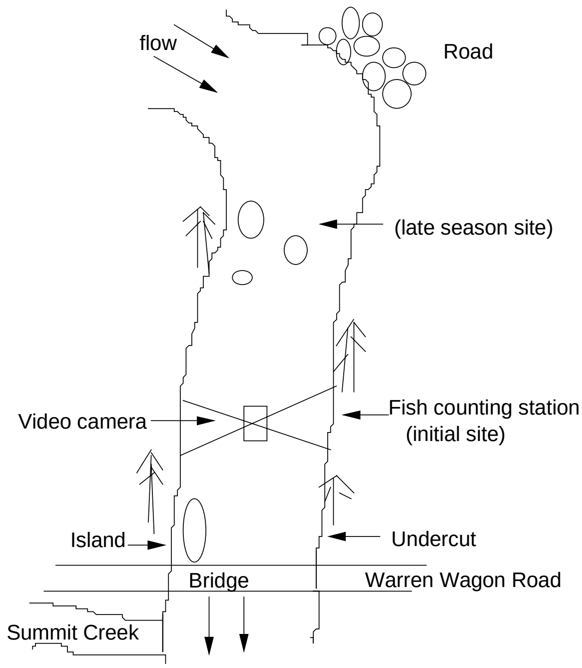


Figure 2. Escapement monitoring project area for snorkel and visual bank observations in Lake Creek in 1999.

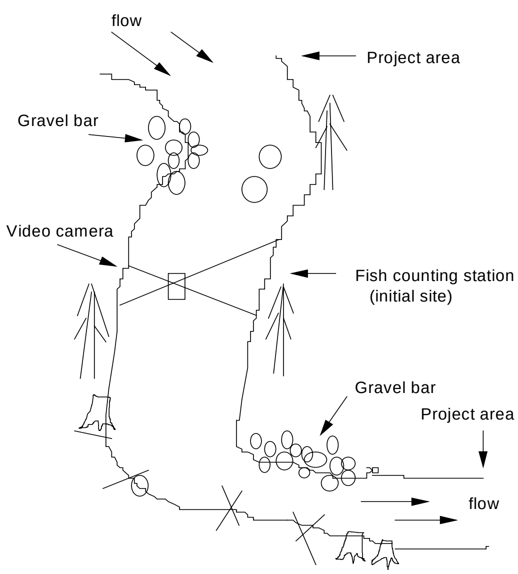


Figure 3. Escapement monitoring project area for snorkel and visual bank observations in the Secesh River in 1999.

Figure 4. Artist's rendition of the underwater video escapement monitoring fish counting station.

Photographs of individual salmon were recorded in time-lapse (2 frames/sec) on 8mm videotape. Artificial red light was provided by two arrays of 36 LEDs (Light Emitting Diodes). Red light was used to eliminate possible fish avoidance of white light. All electrically powered equipment used 12 volt DC power because of the remote location of the sites. Batteries were charged by solar panels at the Secesh River site and by a hydrogenerator at the Lake Creek site. Faurot and Kucera (1999) and Faurot et al. (2000) gave a complete description of the fish counting station. The Lake Creek fish counting station was installed first and operated from July 9 through September 13, 1999. Secesh River operated from July 15 through September 18, 1999.

Procedure

Personnel replaced videotapes and batteries as necessary to ensure efficient project operation. Videotapes were manually analyzed at the regular playback speed at the end of the season. The computerized editing system for video monitoring of fish passage described in Hatch et al. (1998) did not work for our system in 1999. A master fish passage tape consisting of fish passages through the counting chamber was edited from the original tapes. Each time a fish entered the counting station (Figure 5), the date, time and direction of movement were recorded. Sex and presence/absence of an adipose fin were recorded if it could be determined. The shape of the head, in profile, was the primary characteristic used to determine gender. Fullness of the pelvic area could sometimes aid in female determinations. As the spawning migration progressed, male kypes became more pronounced and differentiation was easier. There was concern that sex could not be determined positively. A panel of four fish biologists reviewed the collapsed videotapes and separately recorded their sex determinations. Because an error rate could not be determined (8 % non-agreement), major study results were not presented by sex. Where results by sex were obvious, such as male upstream and downstream movements during the second segment of the run, findings were presented by sex.

Figure 5. Underwater video photograph of a male chinook salmon migrating through the fish counting chamber.

Determination of escapement during the course of the upstream migration was simply a matter of adding to the total as a fish passed upstream, and subtracting as a fish moved downstream. Downstream movement in chinook salmon has been documented in the Kenai River (Bosch and Burwen 1999), Deep Creek (Iverson 1996), Yukon River (Ransom et al. 1998) and Lake creek and the Secesh River (Faurot and Kucera 1999, Faurot et al. 2000, and this report) and at dams (fallback). However, this downstream movement of fish has a tendency to complicate abundance estimates. To minimize the impact of fish wandering while searching for a suitable spawning location, fish counting stations were placed downstream of as much spawning area as feasible. In 1998, we were able to follow multiple passages of uniquely marked individual fish (Faurot and Kucera 1999). Most of these were males, one of which passed through the fish counting station 46 times. Fortunately, most of the up and down male movements occurred after spawning had commenced and escapement numbers were fairly stable. It is acknowledged that some males die and drift downstream through the fish counting station while dying or moving to another spawning area. Numbers wise, late arriving spawners would be seen as those males returning upstream and would not be properly counted. Because of this, results are reported as estimated fish per redd and as a minimum abundance estimate. Review of our 1997, 1998 and 1999 data showed that very few fish passing the fish counting station after spawning had commenced were females. The effect on redd numbers and production would be minimal. To determine the final number of fish that contributed to production it was assumed males could regenerate sperm, and males that dropped out of the system after spawning had commenced, whether they were dying or attempting to locate another female, were assumed to have contributed to production. They could contribute to production in both Lake Creek and the Secesh River. Very few females moved downstream. Females upstream of the fish counting station during the time of spawning were all assumed to have contributed to spawning. Thus, the greatest number of fish above the fish counting stations after spawning commenced were considered to have contributed to spawning.

Corrections for downtime were made by using an average of fish passage, during the hours of lost data, for the two days prior to and after the outage. The National Marine Fisheries Service maintained a water quality monitoring site in the vicinity of the U. S. Forest Service's Chinook Campground near the Secesh River fish counting station, that collected water temperature data every hour during operation.

MONITORING AND EVALUATION

It was acknowledged that some uncertainty existed in terms of migration impedance and/or spawner displacement due to a fish counting station. A Monitoring and Evaluation (M&E) plan was developed to provide safeguards against any potential migration impedance. The plan contained criteria for determining when facility impacts were significant to salmon, guidelines for corrective actions, and a plan implementation schedule. The plan was to be followed for the first three years of operation, provided that it was determined that salmon movement was not impacted. If salmon movement was impacted during the first three years of operation, the M&E plan would be followed in subsequent years until salmon movement was not impacted for two subsequent years. The period of operation was to include a year of high flow and a year of low flow. Snorkel and discrete visual bank observations were used to determine if the fish counting stations were impeding fish movement. Daily observations were conducted both in downstream and upstream locations, after installation of the facility. Particular attention was paid to downstream holding areas. According to M&E plan criteria, if any problems were identified, the pickets or entire counting station could be removed as outlined in the M&E plan. Videotapes were reviewed during the season to follow the progress of the upstream migration, to observe indications of migration impedance, and to check equipment operation. Fish that entered the counting chamber several times within a short time period, but did not continue through would have been an indication that the fish counting chamber was potentially impeding migration.

Two people conducted visual bank observations, on opposite banks, walking from the downstream end to the upstream end of the project area. Observers wore polarized sunglasses. They walked quietly and slowly along the bank looking for fish. If a chinook salmon was sighted, they walked back from the bank to avoid disturbing the fish, walked upstream and continued with the survey. The locations where adult salmon were observed were recorded on a drawing of the project areas.

Underwater observations consisted of two snorkelers, one on each side of the river, drifting downstream looking for fish under banks and around cover. Adult salmon locations were recorded on the project area drawing. Redds and spawning fish were easily detectable during the visual observations and if present were avoided and not disturbed during the snorkel observations. Locations of non-spawning adult chinook salmon that were seen during visual observations were examined closely during snorkel observations.

DESIGN AND PLACEMENT CRITERIA

Operation of the fish counting station structure was compared to water depth and velocity criteria recommended by Hevlin and Rainey (1993). These criteria were examined relative to safety and structural integrity of the facility given the hydrologic conditions at the site. If the recommended criteria could not be safely met the facility could be removed and installed when the criteria were achievable. More importantly, the structure could determine what the criteria actually should be for the specific installation site. That data will be available for future application. Personnel monitored and maintained the fish counting stations on a daily basis. Debris build-up on the guide fences was removed daily or as necessary. Debris loads were extremely heavy leading up to the displacement of the structures at high water. Debris loads were small after the facilities were reinstalled on the descending limb of the hydrograph.

RESULTS AND DISCUSSION

MIGRATION TIMING AND ABUNDANCE

Lake Creek

The Lake Creek fish counting station was installed prior to spring runoff, in 1999 in an attempt to ensure early operation of the facility. Installation of the structure, without pickets and video equipment, occurred on April 29. High water and heavy debris loads dislodged the Lake Creek fish counting station on May 26. It was reinstalled on July 9 and continuous operation began on that date. The first upstream migrating adult salmon passed the site on July 11, two days after the initiation of underwater videotaping (Table 1). This period of no fish passage leads to the conclusion that video coverage of the first fish passage of the adult salmon spawning migration may have occurred in 1999. Net escapement increased rapidly for the first two weeks, slowed for the next two weeks and actually decreased over the final three weeks of the migration (Figures 6 and 7). Fish were in much better condition in 1999 than in 1998, with very few scars or fungus patches.

The Lake Creek fish counting station photographed 65 adult spawners migrating into Lake Creek in 1999. Minor corrections were made for equipment and operator caused downtime (93.2 % operational) during the first segment of the run when fish were

Table 1. Summary of major chinook salmon escapement dates in Lake Creek and the Secesh River, 1998 and 1999.

Activity	Lake Creek 1998	Lake Creek 1999	Secesh River 1998	Secesh River 1999
Start operation	22 June	9 July	10 July	15 July
Continuous operation	1 July	9 July	10 July	15 July
First fish	8 July	11 July	N/A	N/A
Peak net upstream movement	18 July (6)	20 July (14)	17,18 July (10)	20 July (15)
Median net upstream passage	18 July	21 July	N/A	N/A
Peak of activity	7 August (23)	19 August (34)	27 August (55)	16, 18, 19 August 34)
90% net upstream passage	6, 7 August	3 August	N/A	N/A
Last fish	26 August	3 September	10 September	11 September
Stop operation	15 September	13 September	18 September	18 September
Number of Fish Passages	221	418	578	>837
Escapement	52	67	152	>133

actively migrating upstream (Table 2). The remaining lost time occurred in the second segment of the migration (after August 7) when net movement was downstream. With this correction, a minimum estimate of 67 adult chinook salmon contributed to spawning. The adult spawner migration into Lake Creek in 1998 was comprised of a minimum estimate of 52 adult chinook.

The first chinook salmon passed through the fish counting station on July 11 (Table 1). The peak of net upstream movement occurred on 20 July, nine days after the first fish passage, when 14 chinook salmon passed upstream through the fish counting station (Figure 6, Table 1). The median net upstream fish passage occurred July 21 (Figure 7), ten days after the first fish passage and four days later than the median recorded fish passage in 1998 (Table 1). The peak video count for the season occurred on August 8 when a net upstream migration of 65 chinook salmon had been observed through the Lake Creek fish counting station (Appendix Table A-1). The upstream spawning migration was completed at that time and spawning activity in Lake Creek had begun. The peak of spawning activity on Lake Creek spawning areas was between August 10 and 23 (NPT unpublished data). The peak of spawning activity in 1998 was around August 15 to 25 (NPT unpublished data). The fish count above the fish counting station gradually decreased as spawning continued, and dying fish drifted out of the area. The last fish passed downstream through the fish counting station on September 3. When operations ended on 13 September, 50 salmon remained above the fish counting station.

The pattern of migration into Lake Creek was comprised of two behaviorally distinct segments (Figures 6 and 8). Mainly upstream only movement characterized the first segment of salmon movement. The first segment occurred from July 11 to August 7 in

1999 compared to July 8 to 25 in 1998. There were 136 total upstream and downstream movements for an escapement of 62 fish during the first segment of the run.

Table 2. Correction of adult spring and summer chinook salmon spawner escapement abundance estimate at the Lake Creek fish counting station in 1999.

Dates	Hours Lost	Cause	Correction	Comments
7/12	13	Equipment	0	Average of activity during the hours of outage, two days prior and two days after outage
7/14	23	Equipment	+2	Average of activity during the hours of outage, two days prior and two days after outage
7/31	3	Operator	0	Average of activity two days prior and two days after outage
8/9-30	57.5	Operator	0	Net movement was downstream
> 8/30	12	Equipment	0	After last fish had passed

During the second segment of the run, after August 7, movement was upstream and downstream with an overall net downstream movement. There were 280 total movements and a decrease in net escapement of 12 fish. The height of total fish movement activity was from August 11 to 27 when an average of 15 adults moved upstream and downstream per day, with a one-day peak of 34 movements on 19 August (Appendix Table C). This period of active movement was mainly males. The timing of this increased activity appeared to coincide with time of active spawning. Height of total movement activity on Lake Creek was approximately the same time as the height of total movement activity on the Secesh River. In 1998, the height of activity on Lake Creek was two weeks earlier than on the Secesh River. This behavior (increased total activity without increased net upstream movements) is illustrated in Figure 8. This overall downstream movement was attributed to nomadic males that moved in and out of the spawning area and later in the season to downstream drift as males started to die at the end of the season. These earlier departing males appeared to be in good physical condition (i.e. swimming actively with little fungus). They probably tried to spawn again with the later spawning Secesh River spawning aggregate.

The fish counting station remained operational until September 13, an additional 10 days after the last fish passage. The final number of adult chinook salmon considered contributing to production in Lake Creek in 1999 was 67. This number was used for comparisons to redd counts and included 20 jacks. The first jack did not pass the Lake Creek fish counting station until 18 July, seven days after the first adult arrived

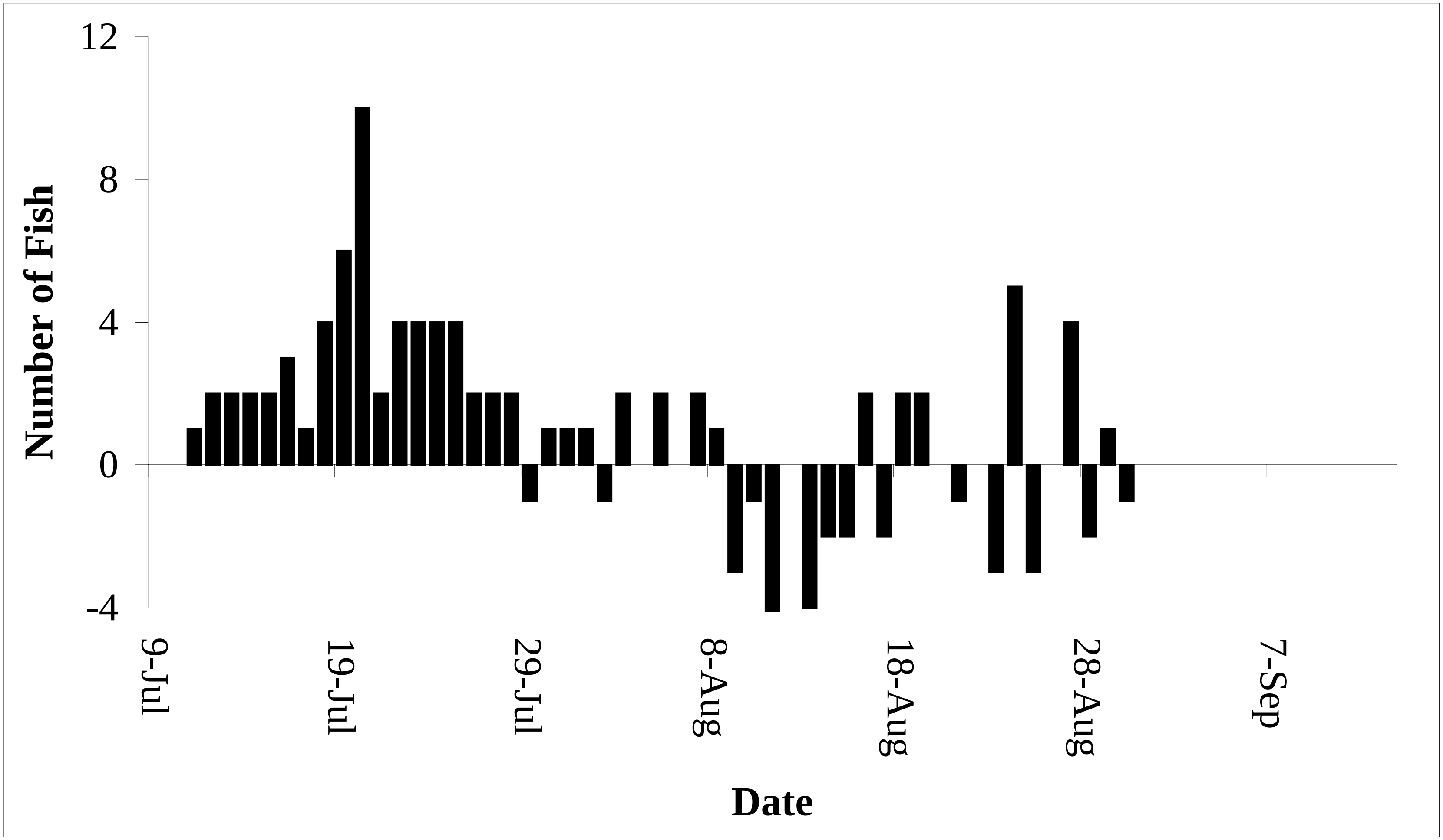


Figure 6. Net upstream spawning migration of adult spring and summer chinook salmon migrating through the Lake Creek fish counting station in 1999.

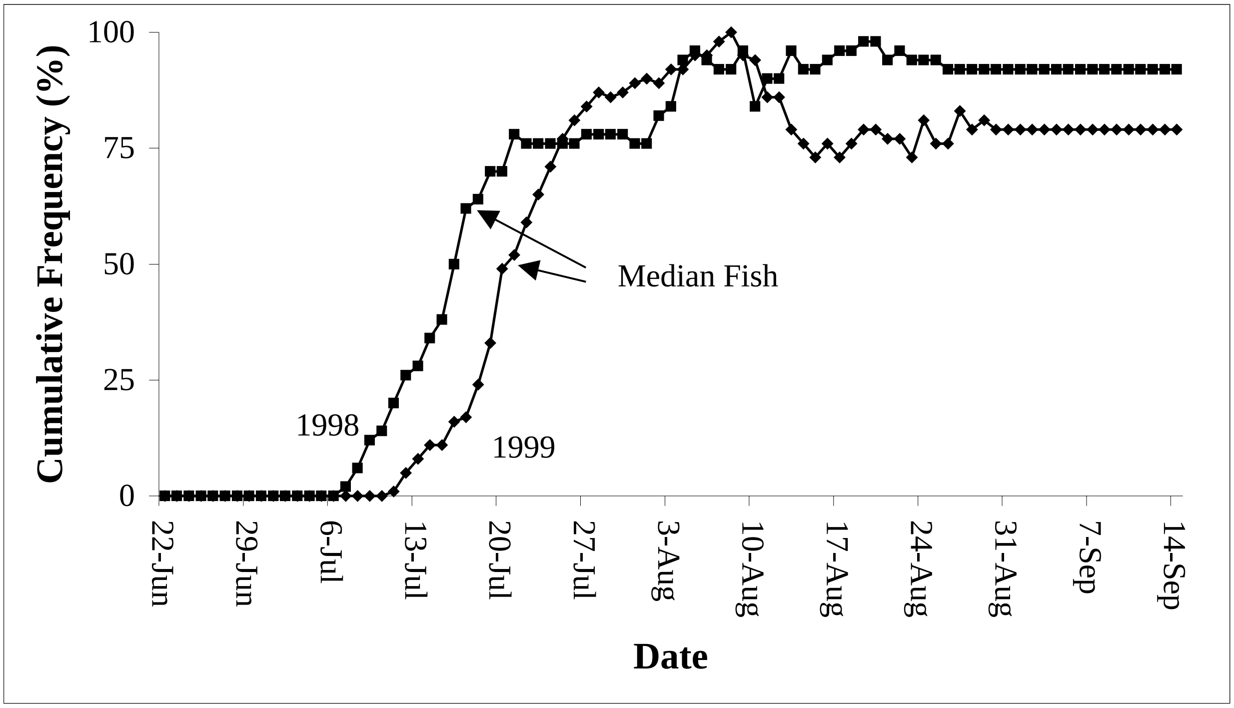


Figure 7. Cumulative frequency of adult spring and summer chinook salmon spawner escapement migrating through the Lake Creek fish counting station in 1998 and 1999.

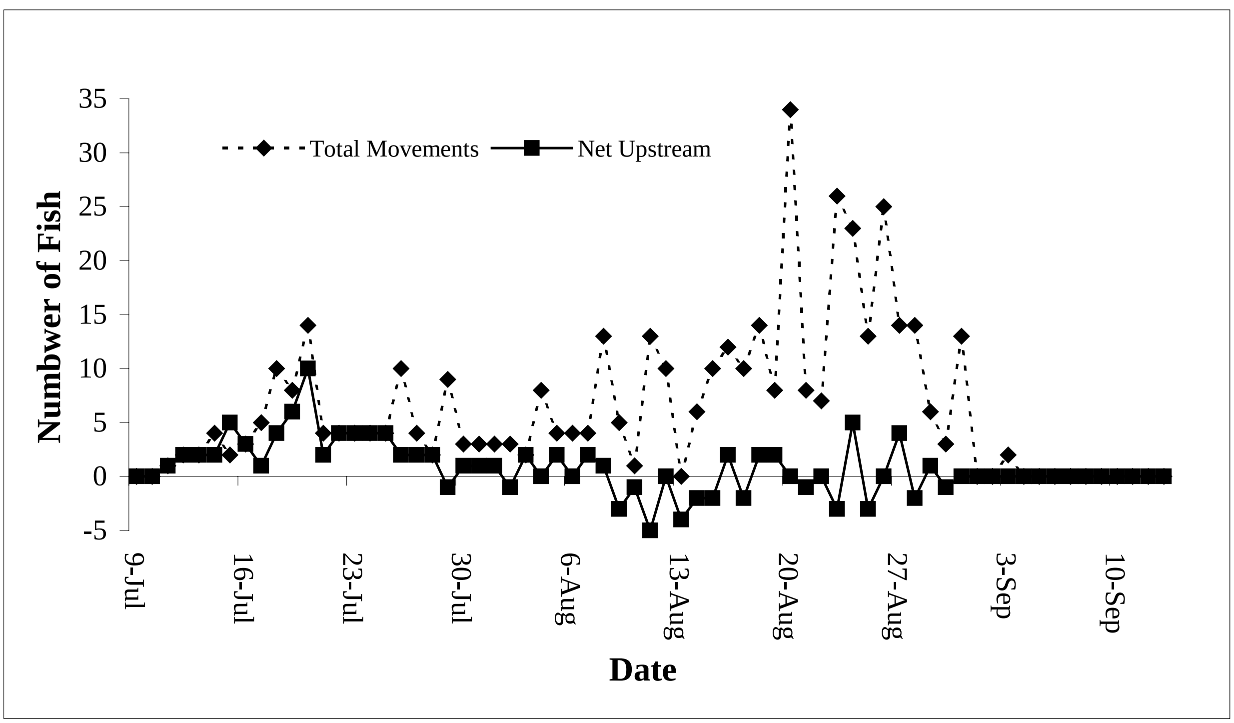


Figure 8. Daily net upstream and total (upstream and downstream) movements of adult spring and summer chinook salmon through the Lake Creek fish counting station in 1999.

Secesh River

The first adult salmon passing the Secesh River site was not photographed in 1997 or 1998. It was a high priority of the project to be operational in 1999 in time to photograph the entire spawning migration. Snow pack in the area was above normal during the winter of 1998 to 1999. Knowing that water could still be high at the time the first salmon was expected, the Secesh River fish counting station, without pickets and video equipment, was installed on May 12, prior to spring runoff. Pickets and video equipment were to be installed as soon as water levels and debris loads decreased. High water and a heavy debris loads dislodged the fish counting station on May 31. As water levels receded, the structure was recovered, repaired and reinstalled on July 15 (Table 1), and the first fish had passed. Once operation began at the Secesh River fish counting station, operation was continuous except for 78 hours of equipment failure and operator error (95 % operational). The videotaped portion of the migration was similar to that seen on Lake Creek. Net escapement increased rapidly for the first two weeks, slowed for the next two weeks and actually decreased over the final three weeks of the migration (Figures 9 and 10).

A minimum of 133 adult chinook salmon contributed to spawning in the Secesh River in 1999. About 40 of those were jacks. Underwater video operation recorded 128 adult spawners migrating into the Secesh River in 1999. Five fish were added to the total due to a loss of data on July 17/18. This correction was an average of the net upstream movement, during the hours of lost data, for the two days prior and two days after the outage. No correction or estimate was made to account for the fish that passed before the site became operational. Of those fish that passed the Secesh River site, an estimated 67, were recorded passing the upstream Lake Creek site. The adult spawner migration into the Secesh River in 1998 was estimated to be 152 adult chinook salmon with no jacks.

The first chinook salmon passed through the fish counting station site prior to installation on July 15 (Table 1). Peak of net upstream movement occurred on July 20, when 15 chinook salmon passed upstream through the fish counting station (Figure 9). Peak of net upstream movement occurred on July 17 and 18 in 1998 (Table 1). Peak count for the season occurred on August 15 when a net upstream migration of 128 chinook salmon (does not include correction for loss of data) had been videotaped through the Secesh River fish counting station (Appendix Table B-1). Spawning migration was completed at that time, and spawning activity in the Secesh River had commenced. Spawning in the Secesh River was about two weeks later than spawning in Lake Creek (NPT unpublished data). Fish count above the Secesh River fish counting station gradually decreased as spawning continued, and dying fish drifted out of the area (Figure 10). The last fish upstream movement was observed on September 10. When operations ended on September 18, 96 salmon remained above the fish counting station. A total of 837 fish movements were photographed passing the fish counting station (Appendix Table B-1).

There were two distinct segments of adult chinook salmon movement at the Secesh River site (Figure 9). These two segments were also observed in 1998. The first segment of salmon movement occurred from before July 15 to August 14 in 1999 and from before July 10 to August 3 in 1998. Movement progressed rapidly, was upstream and consisted of both sexes. There were 402 total upstream and downstream movements for a net upstream escapement of 126 fish during the first segment of the run. The upstream spawning migration was basically completed by that time (Figures 9 and 10). During the second segment of the run, after August 14, movement was upstream and downstream with an overall net downstream movement. There were 435 total movements and a decrease in net escapement of 30 fish. The height of total fish movement activity was from August 11 to 27 when an average of 15 adults moved upstream and downstream per day, with a one-day peak of 34 movements on August 19 (Appendix Table C). This period of active movement was mainly males. The timing of this increased activity appeared to be slightly before the beginning of spawning. This behavior (increased total activity without increased net upstream movements) is illustrated in Figure 11. The overall downstream movement was attributed to nomadic males that moved in and out of the spawning area and, later in the season, to downstream drift of males as they started to die at the end of the season. These earlier departing males appeared to be in good physical condition (i.e. swimming actively with little fungus). Where these males went was unknown as there was very little spawning habitat below the fish counting station for the 30 km to the mouth of the Secesh River. This behavior was also observed at the Lake Creek site. Male salmon that moved downstream from Lake Creek would have had an opportunity to spawn with the later spawning Secesh River spawning aggregate. The last recorded fish passage was upstream and occurred on September 10, when 96 salmon remained above the fish counting station. Counting station observations were concluded on September 18.

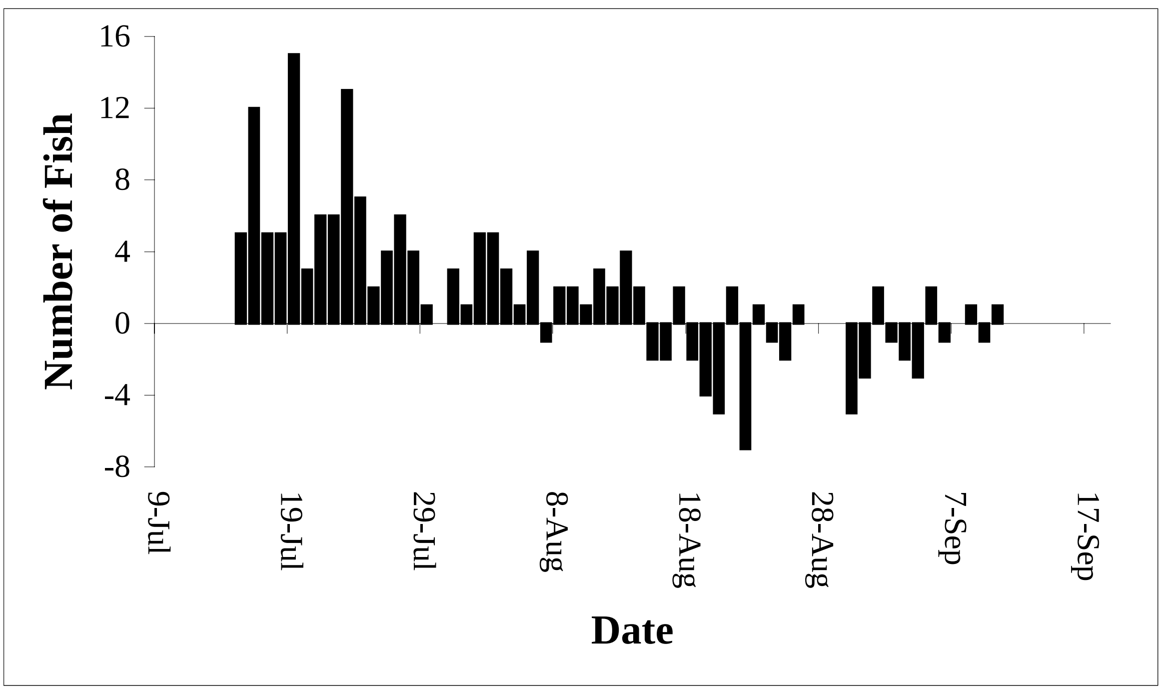


Figure 9. Net upstream spawner migration of adult spring and summer chinook salmon through the Secesh River fish counting station in 1999.

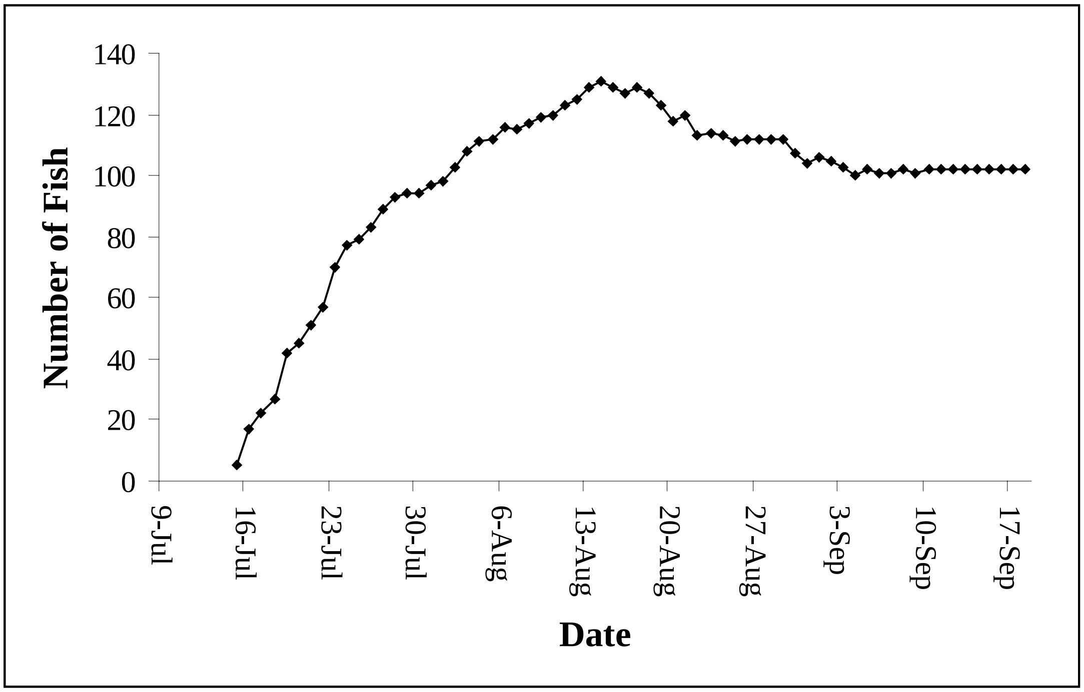


Figure 10. Cumulative number of adult spring and summer chinook salmon spawner escapement migrating through the Secesh River fish counting station in 1999.

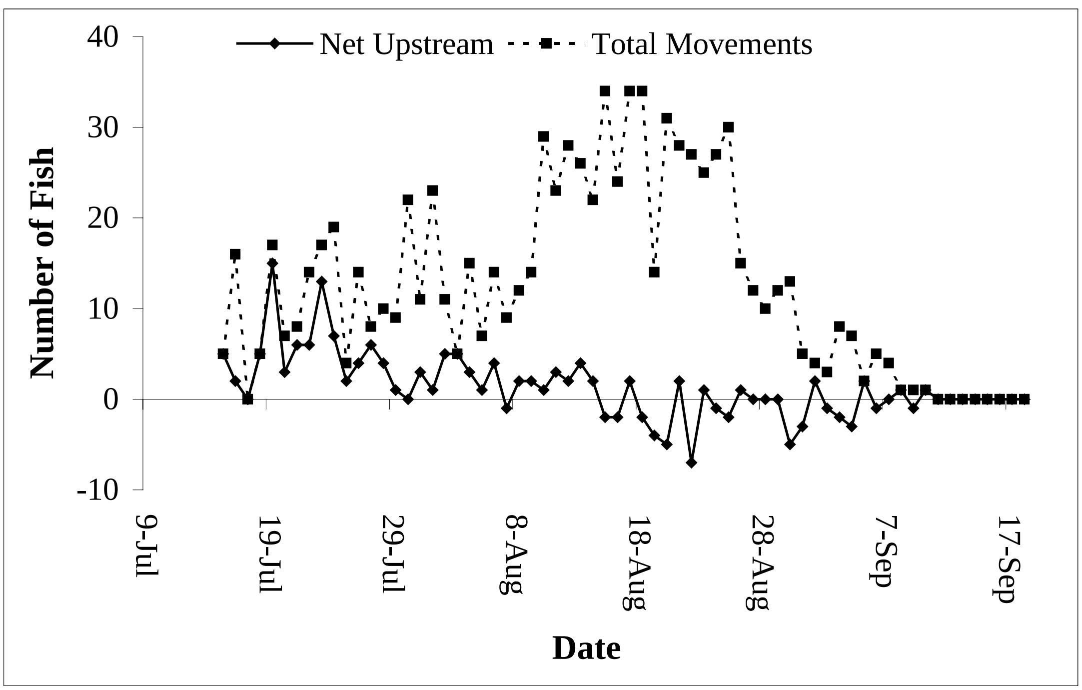


Figure 11. Daily net upstream and total (upstream and downstream) movements of adult spring and summer chinook salmon through the Secesh River fish counting station in 1999.

COMPARISON TO REDD COUNTS

Lake Creek and the Secesh River video fish counting stations estimated a minimum net upstream movement of 67 and greater than 133 spawning chinook salmon, respectively. Based on the number of salmon that migrated into each stream and Nez Perce Tribe redd counts in each stream, the number of fish per redds in spawning areas upstream of the fish counting stations was calculated (Table 3). The fish per redd value in Lake Creek in 1999 was 2.79 fish per redd, including jacks and 1.96 fish per redd, excluding jacks. Within the entire spawning area above the Secesh River fish counting station there were more than 2.15 adults per redd, including jacks and 1.41 fish per redd, excluding jacks. Oregon Department of Fish and Wildlife (unpublished data) reported fish per redd information in the Imnaha River from 1990 to 1994 and 1996 to 1998 from expanded data collected at an adult weir broodstock collection site (Table 3). The number of adult salmon per redd in the Imnaha River averaged 2.78, with a total of 3.42 total fish per redd estimate, including jacks. Fish per redd information on Lookingglass Creek averaged 2.54 adults per redd (range 2.09 – 3.01) from 1967 to 1971

In 1999 the fish per redd numbers from Lake Creek and the Secesh River were within the range of the Imnaha River and Lookingglass Creek data. The 1998 Lake Creek and Secesh River fish per redd numbers were low compared to Imnaha River and Lookinggglass Creek data. In 1998, no jacks passed the fish counting stations into spawning areas of Lake Creek or the Secesh River. In 1999, jacks comprised about half of the male spawning population. At the South Fork Salmon River adult weir, jacks comprised 55 % of the spawning male population in 1999 and 16 % in 1998 (McCall Hatchery unpublished data). The absence of jacks in 1998 could be misleading in terms of year-by-year run strength and fish per redd data.

Two methods have been used to describe chinook salmon spawner abundance in Lake Creek and the Secesh River. The Nez Perce Tribe Department of Fisheries Resources Management conducted multiple-pass surveys of redds to obtain spawner information for year-to-year trends, and for correlation with juvenile chinook salmon emigration from Lake Creek and the Secesh River. Idaho Department of Fish and Game (IDFG) conducted one-pass count of redds in index areas, at the peak of spawning activities. This information is used as an index of annual relative abundance and to describe trends from year to year. Video technology was the second method, and it provided adult spawner abundance information.

Adult salmon spawner abundance data in Lake Creek was compared to expanded redd count information (index area and intensive surveys) to examine the differences between survey methods. Fish per redd numbers typically used by the Idaho Salmon Supplementation Studies (ISS) (3.2 fish/redd) (ISS Draft 1999) and the Plan for Analyzing and Testing Hypothesis (PATH) (2.31 fish/redd) (Beamesderfer et al. 1997) represented the range in values used for redd count expansions. These fish per redd numbers were applied to expand index area redd counts and intensive redd survey redd counts into estimated adult numbers. We then compared the expanded redd count information to the actual adult salmon spawner abundance information as determined by the underwater video technology.

Underwater video technology determined an adult salmon spawner abundance of 67 fish in Lake Creek in 1999 (Table 1). Index area redd counts during that same year totaled 18 redds (IDFG unpublished data**),** and intensive redd count surveys enumerated 24 redds (NPT unpublished data**).** Index area redd count expansion, using the 3.2. and 2.31 fish per redd values, would estimate that 42 to 58 adult salmon were in Lake Creek in 1999. Intensive redd count survey expansion estimated that 55 to 77 adult salmon comprised the Lake Creek salmon spawning population in 1999.

The index area redd count expansion method estimate ranged from 13% to 37% lower than the actual spawner abundance number in 1999. Intensive redd count survey appeared more accurate and estimated from 18% lower to 15% higher than the actual spawner abundance. Fish per redd numbers, 2.79 fish per redd (Table 3), in 1999 were very similar to that reported by other state agencies (Table 3).

Results of redd count expansion methods were even more variable in 1998 when compared to the actual spawner abundance. Salmon spawner abundance in Lake Creek in 1998 was 52 adults (NPT Faurot et al. 2000). Index area redd counts conducted by IDGF totaled 54 redds (Elms-Cockrum 1999), with intensive redd count surveys conducted by NPT enumerating 47 salmon redds (NPT unpublished data). In 1998, index area redd count expansion estimated 125 to 173 adult salmon on Lake Creek spawning grounds. This was 140 to 233% higher than the actual salmon spawner abundance. The intensive redd count survey was also highly variable and estimated 106 to 150 adult salmon, which was 104 to 188% greater than the underwater video technology spawner abundance. Fish per redd numbers in Lake Creek in 1998 were low, averaging 1.18 salmon per redd. There were no jacks in the 1998 Lake Creek spawning migration. This was lower than the average reported by other state agencies in the Snake River basin (Table 3).

It is interesting to note that the index area, which is a part of the intensive area, had a lesser redd count than the larger intensive area. The counts were conducted by different observers at different times. The index count was an IDFG single-pass count and the intensive area count was a NPT multiple-pass count. These differences make it hard to compare data from area to area, count to count and year to year. To further complicate the data, the PATH fish per redd numbers assume one female per redd. Data from fish releases above the South Fork Salmon River weir between 1995 and 2000 show 0.83 females per redd (IDFG unpublished data), while upper Salmon River sites observed 1.24 females per redd (Keifer and Lockhart 1999).

Roger and Schwartzberg (1986) commented on the need for standardization of timing and number of redds counts and establishment of uniform field methods and reporting techniques. Faurot et al. (2000), Beamersdorfer et al. (1997) and Schwartzberg and Roger (1986) discussed sources of errors in spawning ground surveys. These differences in the number of redds makes it difficult to use fish per redd numbers from other agency reports.

Potential sources of errors in determination of spawner abundance by the underwater video methodology are listed in Table 4 and are described in Faurot et al. (2000). All identified sources of error were minimal in Lake Creek, in 1999. The date of facility installation affected Secesh River abundance determination.

Table 3. Fish per redd in Lake Creek and the Secesh River compared to data from the Imnaha River and Lookingglass Creek.

Location	Group	Fish/redd
Secesh River 1998	NPT	>1.36
Secesh River 1999	NPT	>2.15
Lake Creek 1998	NPT	1.18
Lake Creek 1999	NPT	2.79
Imnaha River 1990-94, 1996-98	ODFW	1.68 – 4.04
Lookingglass Creek 1967-1971	ODFW	2.09 – 3.01

Table 4. Potential sources of error in underwater video abundance methodology.

Concern	Potential Effect	
	Lake Creek	Secesh River
Fish passed before installation	Minimal	Moderate
Fish escaped under the pickets or counting station	Minimal	Minimal
Fish escaped around the ends of the fish guiding fences	Minimal	Minimal
Fish passed during high turbidity	Minimal	Minimal
Fish passed during down periods	Minimal	Minimal
Tape observers missed fish passages	Minimal	Minimal

Reliable spawner abundance estimates from unsupplemented salmon spawning aggregates are a necessary tool to monitor ESA listed species. Spawning ground survey trend information is subject to a variety of potential sources of error. Each method should be scrutinized for the differences, so managers better understand what they base decisions upon. This project will continue to make an effort, in future years, to minimize or remove sources of error in salmon spawner abundance determination. Redd count survey methods should attempt to minimize sources of error as well.

MOVEMENT

Diel Movement

Fish counters at mainstem Columbia River and lower Snake River dams have typically discontinued counting anadromous adults at night between 9:00 p.m. and 5:00 a.m. because of low passage rates.

Hatch et al. (1994a) monitored the migration of adult sockeye (*O. nerka*) and chinook salmon at the fish-viewing window at Tumwater Dam on the Wenatchee River in Washington using a time-lapse video recorder system. They found nighttime upstream migration past the dam (between 10:00 p.m. and 4:00 a.m.) to be from 6.7 to 16.2 percent of the daily passage. At Lower Granite Dam on the mainstem Snake River, Hatch et al. (1994b) counted 6.4 percent of the fish migrating upstream at nighttime. Calvin (1975) observed nighttime chinook salmon passage rates between 1.9% to 14.2% at Bonneville, The Dalles, and John Day dams. The diel timing of spring and summer chinook salmon in this spawning tributary system is quite different than those observed above. In 1999, 42% and 53% of the total movement activity and 56% and 107% of the net upstream movement occurred at the Lake Creek and Secesh River fish counting stations, respectively, between 10:00 p.m. and 4:00 a.m (Appendix Table A-2 and B-2). The net upstream movement greater than 100% between 10: p.m. and 4:00 a.m. is possible due to an overall net downstream movement during the rest of the day. In 1998, 49% and 47% of the total movement activity and 82% and 83% of the net upstream movement occurred at the Lake Creek and Secesh River fish counting stations, respectively, between 10:00 p.m. and 4:00 a.m. It appears that in smaller rivers and streams closer to spawning areas, that upstream migration occurs more during periods of darkness.

Net upstream diel movement (upstream minus downstream) showed fish moving both during day and night periods. Net upstream movement was observed between 5:00 p.m. and 6:00 a.m., and downstream movement was highest between 8:00 a.m. and 3:00 p.m. (Figure 12).

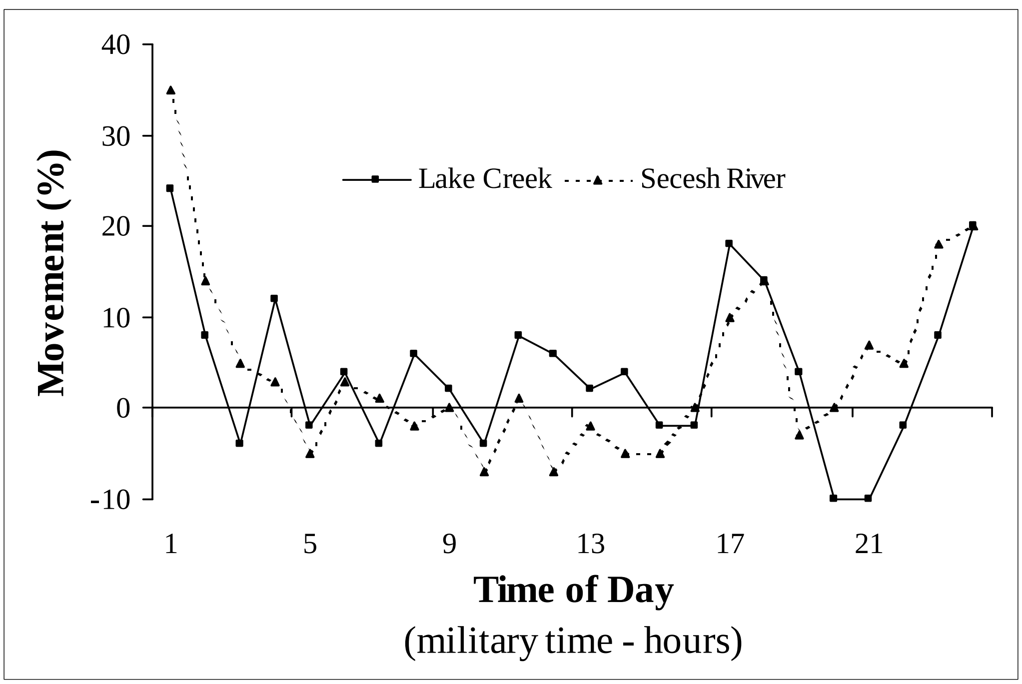


Figure 12. Diel timing of net upstream movements of adult spring and summer chinook salmon through the Lake Creek and Secesh River fish counting stations in 1999.

Upstream/Downstream Movement

The upstream and downstream movement observed at the fish counting stations in 1997 and 1998, was again observed in 1999 at both Lake Creek and Secesh River sites. There were a total of 418 passages past the Lake Creek fish counting station in 1999. This averaged to 6.5 passages for each of the 65 photographed adult salmon. Most of this passage was during the second segment of the run (after August 8). During the second segment of the migration period there were 277 total movements (upstream and downstream) with a net downstream movement of 15 adult salmon. This averaged 18.5 passages for each net downstream passage. During 1998, there was an average of 10.8 passages for each net upstream passage during the second segment of the spawner migration.

There were a total of 837 passages past the Secesh River fish counting station. This averaged to 6.5 passages for each of the 128 photographed adult salmon. Most of this passage was during the second segment of the run (after August 14). During the second segment of the migration there were 411 total movements (upstream and downstream) with a net downstream movement of 30 adult salmon. This averaged to 13.7 passages for each net downstream passage. Comparatively, the second segment of the 1998 run began on August 5, consisted of 427 total movements with a net upstream movement of 30 adult salmon. This averaged out to 13.8 passages for each net upstream passage.

This large upstream/downstream movement of males, in particular, suggested movement of males between the Lake Creek and Secesh River spawning aggregates. Female salmon appeared to have more fidelity to their spawning location. The highest video escapement count at the Lake Creek fish counting station occurred on August 8, 1999, and was used in final abundance determination. The first redd count survey on Lake Creek on August 10 found five completed redds, two test redds and six redds in progress. The second redd count survey of that area on August 23 found an additional 14 new redds, four test redds and one redd in progress. By that date the video count of fish in Lake Creek site had decreased by 15 fish. The condition of the fish, the amount of activity through the video station (zero net movement of females) and the swimming appearance on the videotapes indicates these males were not passively drifting downstream as they died. These males were available to spawn again outside of the Lake Creek spawning aggregate in the Secesh River. There were also indications this same behavior occurred in the vicinity of the Secesh River fish counting station. The maximum spawner count above the Secesh River fish counting station was on August 15, 1999. During the redd count survey on August 16, one completed redd and six redds in progress were recorded. On August 30, during the second redd count survey, seven additional completed redds and three test redds were recorded. During that time period, the video count of fish above the Secesh River site had decreased by 25 fish, mostly males. On September 14, the third redd count survey of the reach, five additional completed redds were observed. There is limited suitable spawning habitat downstream of the video site until the Secesh River flows into the South Fork Salmon River.

DESIGN AND PLACEMENT CRITERIA

The rate of upstream and downstream movement documented in this report points out the importance of properly designed and placed structures in anadromous fish streams. Structures that allow only upstream passage prevent downstream movement, which appears to be much larger than previously thought. Structures that provide for downstream passage should be designed to enhance the ease of downstream passage. Studies have documented that improperly placed or designed structures can impede upstream passage and displace spawning downstream (Hevlin and Rainey 1993). This study also shows the potential for preventing freedom of movement downstream. This

could artificially inflate estimation of stray rates depending on adult weir site location.. Conventional hatchery collection facilities are a classic example of allowing upstream migration only.
Equally important as structures that pass fish freely in both directions would be the proper placement of structures in streams. The recommended criteria from Hevlin and Rainey (1993) did not appear to be realistic in Lake Creek and the Secesh River. The general design guidelines, rather than specific water depths and velocities appeared to be most beneficial even though they were meant for small dams and diversion structures along migration routes and mainstem rivers. A general guideline of using the thalweg with angled guide fences would appear to be better for small streams.

It was felt the best available fish counting sites were selected. Priorities in selection of the site were that it be downstream of as much spawning area as possible, in a straight stretch of river, with a low gradient and a uniform bottom. The counting chamber was placed in the thalweg. Upstream and downstream fish guiding fences were installed at a 30 to 45 degree angle to orient and guide fish into the opening for passage.

MONITORING AND EVALUATION

A Monitoring and Evaluation plan was put in place to detect if the fish counting structure impeded upstream adult passage or if spawning was displaced downstream. The Plan criteria to determine if the fish counting station was impacting salmon migration, was the observation of three to ten or more adult salmon holding below the count station for more than three consecutive days, while no salmon were observed passing the counting station. During 51 visual bank observations at Lake Creek, three adult chinook salmon were observed, one in the counting chamber and two downstream. During 43 snorkel observations in Lake Creek, six adult chinook salmon were seen, one in the counting chamber, three downstream and two upstream. There were 418 passages and a net upstream movement of 67 adult spring and summer chinook salmon through the Lake Creek fish counting station in 1999. No spawning took place in Lake Creek downstream of the fish counting station (Figure 2). It appeared that the Lake Creek fish counting station neither impeded upstream migration nor displaced spawning downstream.

During 55 visual bank observations at the Secesh River, no adult chinook salmon were observed. During 45 snorkel observations, 12 adult chinook salmon were seen, six downstream, five upstream and one in the counting chamber. There were 837 passages and a net upstream movement of greater than 133 videotaped adult spring and summer chinook salmon through the Secesh River fish counting station in 1999. There was no spawning activity in the project area (Figure 3). There are several sites downstream of the fish counting station where spawning has been known to take place in previous years. In 1999, no spawning took place in the Secesh River downstream of the fish counting station (Table 5). It appeared that the Secesh River fish counting station neither impeded upstream migration nor displaced spawning downstream.

There was no correlation between visual bank observations and snorkel observations of adult salmon. Even though the visual survey occurred first and snorkelers soon afterwards searched for fish in the observed location, non-spawning chinook salmon were not observed at the same location by snorkelers. Fish observed by snorkelers usually were holding very tight under banks and had not been observed by the visual bank observers. No fish could be identified as being in any location for more than one day at a time.

Multiple passages of fish indicated that upstream and downstream passage was not hampered by the structure. The counting chamber itself did not appear to bother fish either, as evidenced by the fish that entered the Lake Creek counting chamber on July 19 and held there for four hours and 23 minutes. In view of the large number of fish passages, upstream and downstream, and at all times of the day and night, it was felt the counting station was well designed and positioned. Fish were allowed to move freely upstream or downstream. Personnel at the site performing daily operations, never heard or saw fish jumping at the fish guiding pickets, holding directly downstream of the fish guiding fences, or moving back and forth behind the pickets. Never were three to ten or more adult salmon observed holding below the fish counting station for three consecutive days. Because of the above conditions, it was concluded there was no impedance to fish movement, and corrective actions were not necessary in 1999.

Between 1992 and 1996, with no fish counting facility in place, the percentage of chinook redds observed downstream of the fish counting site ranged from 0 to 8.2%. With the fish counting station in place, 0 % of the total redds were observed downstream of the Secesh River fish counting station in 1999, 1.8 % in 1998 and 4.0 % in 1997. The number and percent of redds observed spawning below the fish counting station in all three years were within the range observed since 1992 (Table 5). It appeared that the fish counting station did not displace chinook salmon spawning activity from upstream of the fish counting station to downstream sites (Table 5).

Table 5. Spring and summer chinook salmon redd counts in the Secesh River and Lake Creek index areas, and in the Secesh River from the fish counting station downstream to the canyon, 1992 to 1999.

	Number of Redds by Index Area				
	Lake Creek		Secesh River		
Year	IDFG Index	NPT Intensive	NPT Intensive	Secesh River Fish Counting Station to Canyon	Percent of Redds Below Secesh River Fish Counting Station
1999	18	24	43	0	0.0
1998	54	47	68	2	1.8
1997		46	78	5	4.0
1996		31	43	1	1.4
1995		12	18	0	0.0
1994		12	17	0	0.0
1993		44	94	7	5.1
1992		43	66	10	8.2

The conditions of the Monitoring and Evaluation Plan have been met for three consecutive years from 1997 to 1999 (Table 6). Observations included a higher than average flow year and a year of lower than average flows. Movement of adult salmon through the fish counting station has not been impeded, nor has spawning been displaced downstream. Daily snorkel and visual bank observations will not be conducted in the future. Observations will be conducted on a random basis, or if fish are observed or seen jumping at the pickets. Percent of spawning downstream of the Secesh River fish counting site will continue to be evaluated annually to compare to the percent of spawning before project operation.

Table 6. Effects of the Secesh River and Lake Creek fish counting stations on adult spring and summer chinook salmon movement, 1997 to 1999.

Activity	Year	Lake Creek	Secesh River
Snorkel	1997	N/A	No impact
Snorkel	1998	No impact	No impact
Snorkel	1999	No impact	No impact
Visual Bank	1997	N/A	No impact
Visual Bank	1998	No impact	No impact
Visual Bank	1999	No impact	No impact

FORK LENGTHS

Fish returning to the South Fork Salmon River weir were assigned to age groupings according to fork length. Fish less than 67 mm were called three year olds (jacks); 68-89 mm were four year olds, and greater than 90 mm were five year olds. Visual fork lengths of fish were taken using the 10 cm grid system painted on the back and bottom plates of the fish counting chamber. Position and orientation of the adult salmon in the counting chamber affected estimated fish length. Lengths were not accurate to +/- 5 cm and were rounded to the nearest 10 cm. This was not satisfactory to develop distinct age groups. Length assignments appeared to vary by different video observer. The spawning migration appeared to be comprised mainly of jacks and four year old fish. Visual determination of lengths from videotapes was not satisfactory. Laser beam equipment for length measurements did not arrive in time for use in 1999. It will be applied in 2000 to attempt to accurately determine fish lengths.

TEMPERATURE

Water temperatures in the Secesh River in 1999, ranged from a low of 0.4 C on June 28, to a high of 18.2 C on August 27 (Figure 12) (Table 7). Water temperatures during the active upstream migration (first segment) ranged from 7.4 C to 17.4 C. Temperatures the day of peak net upstream movement ranged from 8.0 C to 13.5 C. The peak of the total activity, of adult chinook salmon spawner movement through Secesh River fish counting station occurred August 19, with temperatures between 11.6 and 17.6 C. Water temperatures were generally cooler in 1999 than in 1998.

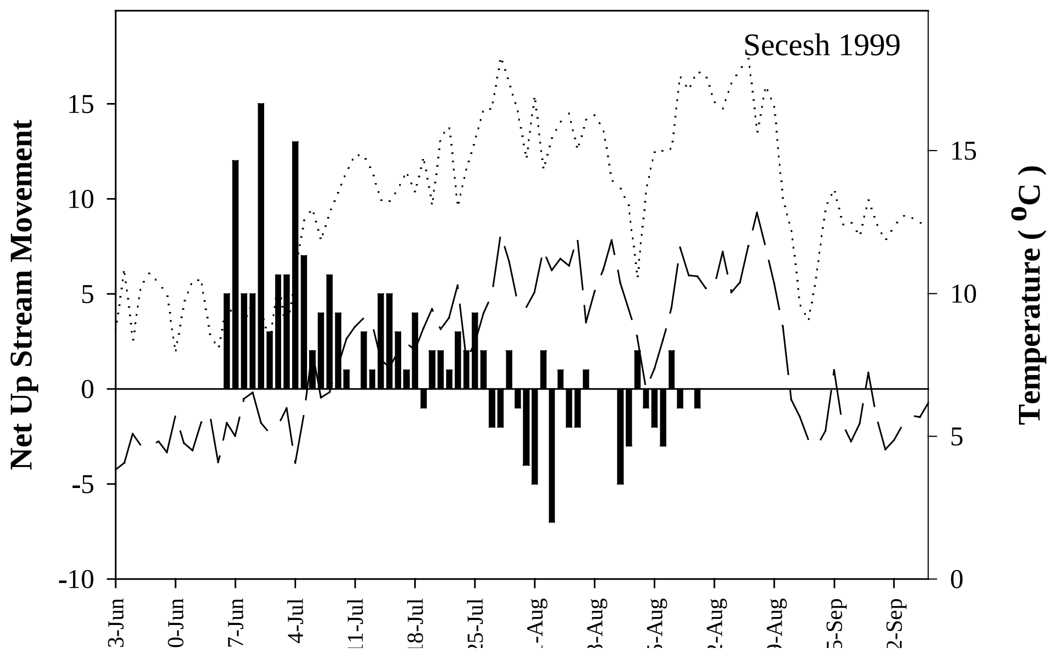


Figure 13. Daily maximum and minimum temperatures and chinook salmon net upstream escapement through the Secesh River fish counting station in 1999.

Table 7. Water temperatures in the vicinity of Chinook Campground, Secesh River, and adult spring and summer chinook salmon activity through the Secesh River fish counting station, 1998 and 1999.

Activity		Date	Temperature Range (C)
Operation	1998	7/10 – 9/18	4.9 to 19.5
	1999	7/15 – 9/18	0.4 to 18.2
First Fish	1998	N/A	N/A
	1999	N/A	N/A
First Segment	1998	<7/10 – 8/3	9.9 to 19.0
	1999	<7/15 – 8/14	7.4 to 17.4
Peak Net Upstream Movement	1998	N/A	N/A
	1999	N/A	N/A
Peak Activity	1998	8/27	8.3 to15.7
	1999	8/17	8.4 to 15.0

RECOMMENDATIONS

- Install the fish counting stations early enough to record the first fish passage at both sites. Fish counting stations will be operated in the Secesh River and Lake Creek in 2000. It appears that Lake Creek fish counting station can be installed prior to the first fish arrival in most years. Installation of the Secesh River fish counting station will be a higher priority in 2000.

- Use the computerized system for editing videotapes. With improvements in the software, the computerized editing system may be workable. Manual editing will be a backup method and provide a quality control. Fast–forward tape review would provide a daily check of equipment operation. Fish passages would be directly edited/collapsed (at slow speed) onto another tape as time permits.

- Provide extensive training to personnel. Early operation of the fish counting station would allow additional training of personnel before fish start actively migrating. This should reduce down time due to operator error and, with the additional experience, operators would be able to quickly identify and trouble shoot equipment malfunctions.

- Improve the lighting conditions in the fish counting chambers. The computerized editing system is triggered by contrast along transect lines on the videotape. Uneven sunlight and turbulence bubbles that reflect artificial night light trigger the editing system.

- Evaluate the use of laser technology to provide accurate fish length determination.

- Investigate methods for better sex determinations. The proper sex identification of adult chinook salmon from videotapes, especially early in the season, is an important factor relating number of females to redds, total escapement, and subsequent production. Methods of determining sex of adult chinook salmon by multiple reviewers and the use of ultrasound will be investigated.

LITERATURE CITED

Beamesderfer, R. C. P., H. A. Schaller, M. P. Zimmerman, C. E. Petrosky, O. P. Langness, and L. LaVoy. 1997. Spawner-recruit data for spring and summer chinook salmon populations in Idaho, Oregon and Washington. Draft report to Marmorek, D. R., and C. N. Peters (eds.). J. Anderson, R. Beamesderfer, L. Botsford, J. Collie, B. Dennis, R. Deriso, C. Ebbesmeyer, T. Fisher, R. Hinrichsen, M. Jones, O. Langness, L. LaVoy, G. Matthews, C. Paulsen, C. Petrosky, S. Saila, H. Schaller, C. Toole, C. Walters, E. Weber, P. Wilson, M. P. Zimmerman. 1998. Plan for Analyzing and Testing Hypotheses (PATH): Retrospective and Prospective Analysis of Spring/Summer Chinook Reviewed in FY 1997. Compiled and edited by ESSA Technologies Ltd. Vancouver, B. C.

Bjornn, T. C., R. R. Ringe, K. R. Tolotti, P. J. Keniry, J. P. Hunt, C. J. Knutsen, and S. M. Knapp. 1992. Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into tributaries – 1991. U. S. Corps of Engineers Technical Report 92-2. Walla Walla District, WA.

Bjornn, T. C., J. P. Hunt, K. R. Tolotti, P. J. Keniry, R. R. Ringe, S. M. Knapp, and C. J. Knutsen. 1994. Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into tributaries – 1992. U. S. Corps of Engineers Technical Report 94-1. Walla Walla District, WA.

Bjornn, T. C., J. P. Hunt, K. R. Tolotti, P. J. Keniry, and R. R. Ringe. 1995. Migration of adult chinook salmon and steelhead past dams and through reservoirs in thelower Snake River and into tributaries – 1993. U. S. Corps of Engineers Technical Report 95-1. Walla Walla District, WA.

Bosch, D. and D. Burwen. 1999. Estimates of Chinook salmon abundance in the Kenai River using split-beam sonar, 1997. Alaska Department of Fish and Game, Fisheries Data Series No.99-3. Anchorage, Alaska.

Botkin, D. B., D. L. Peterson, and J. M. Calhoun (technical editors). 2000. The scientific basis for validation monitoring of salmon conservation and restoration plans. Olympic Natural Resources Technical Report. University of Washington, Olympic Natural Resources Center. Forks, Washington, USA

Bowles, E. and E. Leitzinger. 1991. Salmon supplementation studies in Idaho rivers (ISS). Experimental design. Idaho Department of Fish and Game. Prepared for Bonneville Power Administration. Portland, OR.

Calvin, L.D. 1975. Estimating Night Fish Passage over Bonneville, The Dalles and John Day Dams. U.S. Corps of Engineers Report, Portland District, OR.

Cowley, K. and P. Kucera. 1989. Chinook salmon spawning ground survey in Big Creek, Johnson Creek, Secesh River and Lake Creek, Salmon River subbasin, Idaho 1989. Nez Perce Tribe Department of Fisheries Management. Lapwai, Idaho.

Elms-Cockrum, T. E. 2000. Salmon spawning ground surveys, 1998. Idaho Department of Fish and Game. Pacific Salmon Treaty Program: Award No. NA67FP0325 IDFG 99-32, November 1999. 26 p. plus appendices.

Faurot, D. and P. A. Kucera. 1999. Escapement Monitoring of Adult Chinook Salmon in the Secesh River and Lake Creek, Idaho, 1997. Annual Report to the U. S. Department of Energy, Bonneville Power Administration by the Nez Perce Tribe Department of Fisheries. Contract No. 97AM30423, Project No. 97-030.

Faurot, D., P. A. Kucera and J. Hesse. 2000. Escapement Monitoring of Adult Chinook Salmon in the Secesh River, Idaho, 1998. Annual Report to the U. S. Department of Energy, Bonneville Power Administration by the Nez Perce Tribe Department of Fisheries. Contract No. 97AM30423, Project No. 97-030.

Fish Management Consultants. 1991. Feasibility, design and location of a weir for escapement estimation of summer chinook salmon in the Secssh River, Idaho. Report prepared for the Nez Perce Tribe. Fish Management Consultants, Olympia, WA.

Foose, T. J. ,L. deBour, U. S. Seal and R. Lande. 1995. Conservation Management Strategies based on viable populations. Pages 273-294 *in* J. D. Ballou, M. Gilpin and T. J. Foose eds. Population Management for Survival and Recovery. Columbia University Press. New York, Chichester, West Sussex.

Hatch, D.R., M. Schwartzberg, and P.R. Mundy. 1994a. Estimation of Pacific Salmon Escapement with a Time-Lapse Video Recording Technique. North American Journal of Fisheries Management 14:626-635.

Hatch, D.R., D.R. Pederson, J.K. Fryer, M. Schwartzberg, and A. Wand. 1994b. The Feasibility of Documenting and Estimating Adult Fish Passage at Large Hydroelectric Facilities in the Snake River Using Video Technology. Columbia River Inter-Tribal Fish Commission, Annual Report to Bonneville Power Administration, Contract DE-BI79-92BP61404.

Hatch, D. R., J.K. Fryer, M. Schwartzberg, D.R. Pederson, and A. Wand. 1998. A Computerized Editing System for Video Monitoring of Fish Passage. North American Journal of Fisheries Management 18(3) 694-699.

Hevlin, W. and S. Rainey. 1993. Considerations in the Use of Adult Fish Barriers and Traps in Tributaries to Achieve Management Objectives. Paper presented at the National American Fisheries Society Annual Meeting, 1993, Portland, OR.

Holubetz, T. B., and B.D. Leth. 1996. Evaluation and Monitoring of Wild/Natural Steelhead Trout Production. Annual Progress Report to BPA, 1995. Idaho Department of Fish and Game. Boise, ID.

ISS. Draft. Idaho Salmon Supplementation Studies: Five year report 1992 – 1996. Prepared for BPA, Project Number 89-098. IDFG Report Number 99-14, Boise, ID.

Iverson, T. K. 1996. Hydroacoustic evaluation of adult chinook salmon in Deep Creek during 1996: second year feasibility study. Report to Alaska Department of Fish and Game, Division of Sport Fish, Anchorage, Alaska.

Kiefer, R. B. and J. N. Lockhart. 1999. Intensive evaluation and monitoring of chinook salmon and steelhead trout production, Crooked River and upper Salmon River sites. Annual Progress Report, IDFG Report Number 00-15, Boise, ID.

Keifer, R. B., J. Johnson and D. Anderson. Draft 2001. Natural production monitoring and evaluation: Objective 4: Monitoring age composition of wild adult spring and summer chinook salmon returning to the Snake River Basin. Prepared for BPA project Number 91-73, IDFG Report Number 00-- Boise, ID.

Kucera, P.A. 1987. Chinook salmon spawning ground survey in Big Creek, Johnson Creek, Secesh River and Lake Creek, Salmon River subbasin, Idaho 1987. Nez Perce Tribe Department of Fisheries Management. Lapwai, Idaho.

Kucera P. A. and M. J. Banach. 1991. Chinook salmon spawning ground survey in Big Creek, Johnson Creek, Secesh River and Lake Creek, Salmon River subbasin, Idaho - 1990. Nez Perce Tribe Department of Fisheries Management. Lapwai, Idaho.

Kucera P. A. and M.L. Blenden. 1993. Chinook salmon spawning ground survey in Big Creek, and tributary streams of the South Fork Salmon River, Idaho – 1992 - 1995. Asessment of the status of salmon spawning aggregates in the Middle Fork Salmon River and South Fork Salmon River. Nez Perce Tribe Department of Fisheries Management. Technical Report 99-7. Lapwai, Idaho.

Kucera P. A. and M.L. Blenden. 1999. Chinook salmon spawning ground survey in Big Creek, and tributary streams of the South Fork Salmon River, Idaho - 1991. In LSRCP Evaluation Studies Annual Report – 1991. AFF1/LSR-94-12. Nez Perce Tribe Department of Fisheries Management. Lapwai, Idaho.

NMFS (National Marine Fisheries Service). 1992. Threatened status for Snake River spring/summer chinook salmon, threatened status for Snake River fall chinook salmon, final rule. Federal Register 57:78 (22 April 1992) 7:14, 653,663.

NMFS (National Marine Fisheries Service). 2000. Final Biological Opinion: Operation of the federal Columbia River power system including the juvenile fish transportation program and the Bureau of Reclamation's 31 projects, including the entire Columbia Basin Project. December 21, 2000

Ransom, B. H., S. V. Johnston and T. W. Steig. 1998. Review on monitoring adult salmonid (*Oncorhynchus and Salmo* spp.) escapement using fixed location split-beam hydroacoustics. Fisheries Research 35 (1998) 33-42.

River Masters Engineering. 1994. Preliminary design of a non-impeding fish counting facility in the Secesh River for adult summer chinook. Prepared for Nez Perce Tribe Fisheries Resources Management. Pullman, WA.

Roger, P. B. and M. Schwartzberg. 1986. An annotated compendium of spawning ground surveys in the Columbia River Basin above Bonneville Dam, 1960-1984. Columbia River Inter-Tribal Fish Commission Technical Report 86-1. Portland, OR.

Schwartzberg, M. and P. B. Roger. 1986. Observations on the accuracy of redd counting techniques used in the Columbia basin. Columbia River Inter-Tribal Fish Commission Technical Report 86-2.

APPENDIX A

Table A-1. Run timing and direction of adult spring and summer chinook salmon passing the escapement monitoring fish counting station in the Secesh River in 1999.

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
15-Jul	18:26	80	F	Up	1
15-Jul	19:58	90	F	Up	2
15-Jul	19:58	90	M	Up	3
15-Jul	22:52	90	M	Up	4
15-Jul	23:23	80	M	Up	5
16-Jul	5:30	90	M	Down	4
16-Jul	7:27	90	M	Up	5
16-Jul	7:27	90	M	Up	6
16-Jul	10:02	-	F	Up	7
16-Jul	11:53	90	M	Down	6
16-Jul	15:54	80	M	Up	7
16-Jul	16:49	80	F	Up	8
16-Jul	17:01	70	F	Up	9
16-Jul	17:01	70	F	Up	10
16-Jul	17:01	50	M	Up	11
16-Jul	17:34	70	F	Up	12
16-Jul	22:55	70	F	Up	13
16-Jul	23:09	70	M	Up	14
16-Jul	23:14	80	M	Up	15
16-Jul	0:18	50	M	Up	16
16-Jul	6:43	90	M	Up	17
18-Jul	20:43	60	M	Up	18
18-Jul	20:43	60	M	Up	19
18-Jul	21:00	-	M	Up	20
18-Jul	23:12	70	F	Up	21
18-Jul	23:20	80	F	Up	22
19-Jul	0:06	80	F	Up	23
19-Jul	0:55	80	F	Up	24
19-Jul	0:57	60	M	Up	25
19-Jul	1:14	80	M	Up	26
19-Jul	2:43	80	F	Up	27

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
19-Jul	13:35	80	M	Up	28
19-Jul	15:37	60	M	Up	29
19-Jul	21:53	60	M	Up	30
19-Jul	22:10	50	M	Up	32
19-Jul	22:36	80	M	Up	33
19-Jul	22:43	80	F	Up	34
19-Jul	22:47	80	M	Up	35
19-Jul	22:50	50	M	Up	36
19-Jul	22:57	80	M	Up	37
19-Jul	23:35	80	M	Down	36
19-Jul	23:37	80	F	Up	37
20-Jul	1:40	80	M	Up	38
20-Jul	1:59	90	M	Up	39
20-Jul	2:15	80	F	Down	38
20-Jul	4:49	90	M	Up	39
20-Jul	5:19	90	M	Down	38
20-Jul	12:41	70	F	Up	39
20-Jul	14:54	70	M	Up	40
21-Jul	15:03	60	M	Down	39
21-Jul	16:55	80	F	Up	40
21-Jul	19:47	80	M	Up	41
21-Jul	20:34	70	F	Up	42
21-Jul	22:19	50	M	Up	43
21-Jul	22:35	50	M	Up	44
21-Jul	23:39	90	F	Up	45
21-Jul	23:49	80	F	Up	46
22-Jul	0:06	80	M	Up	47
22-Jul	0:22	80	F	Up	48
22-Jul	3:11	80	F	Up	49
22-Jul	3:18	60	M	Up	50
22-Jul	4:38	80	M	Down	49
22-Jul	5:16	50	M	Up	50
22-Jul	10:58	80	F	Down	49
22-Jul	14:18	70	M	Up	50
22-Jul	16:57	60	M	Up	51

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
22-Jul	21:30	70	M	Up	52
22-Jul	22:14	70	M	Up	53
22-Jul	22:46	90	M	Down	52
22-Jul	23:47	80	F	Up	53
22-Jul	23:57	80	F	Down	52
23-Jul	0:06	80	F	Up	53
23-Jul	0:10	80	M	Up	54
23-Jul	0:27	80	F	Up	55
23-Jul	0:34	90	F	Up	56
23-Jul	0:48	80	F	Up	57
23-Jul	2:19	80	M	Down	56
23-Jul	3:39	50	M	Up	57
23-Jul	3:44	50	M	Up	58
23-Jul	4:11	80	F	Up	59
23-Jul	4:23	80	F	Down	58
23-Jul	5:23	50	M	Up	59
23-Jul	5:45	50	M	Up	60
23-Jul	18:53	60	M	Up	61
23-Jul	21:33	60	M	Up	62
23-Jul	22:27	60	M	Up	63
23-Jul	23:29	80	F	Up	64
23-Jul	23:39	80	F	Up	65
24-Jul	0:03	80	F	Up	66
24-Jul	0:43	80	M	Up	67
24-Jul	1:08	50	M	Up	68
24-Jul	1:51	80	M	Up	69
24-Jul	1:51	80	M	Down	68
24-Jul	2:46	80	M	Down	67
24-Jul	4:00	90	M	Up	68
24-Jul	4:58	80	M	Down	67
24-Jul	6:15	70	F	Down	66
24-Jul	17:24	70	M	Up	67
24-Jul	17:24	70	M	Up	68
24-Jul	22:07	50	M	Up	69
24-Jul	22:32	70	M	Down	68

Table A-1 (continued).

Date	Time	Length	Estimated Sex	Direction	Net Upstream

(1999)	(hours)	(cm)	(M/F)	(Up/Down)	Movement
24-Jul	22:32	80	M	Down	67
24-Jul	23:20	80	M	Up	68
24-Jul	23:28	70	M	Up	69
24-Jul	23:36	60	M	Up	70
24-Jul	23:52	50	M	Up	71
24-Jul	23:57	80	M	Up	72
25-Jul	0:08	70	F	Up	73
25-Jul	0:11	90	M	Up	74
25-Jul	0:35	50	M	Up	75
25-Jul	5:39	50	M	Down	74
26-Jul	0:03	60	M	Up	75
26-Jul	1:00	90	M	Down	74
26-Jul	2:24	80	F	Up	75
26-Jul	2:30	60	M	Down	74
26-Jul	2:49	90	M	Up	75
26-Jul	3:38	80	M	Down	74
26-Jul	4:20	80	F	Up	75
26-Jul	4:46	60	M	Up	76
26-Jul	6:08	80	F	Down	75
26-Jul	19:24	70	F	Up	76
26-Jul	20:22	50	M	Up	77
26-Jul	20:22	50	M	Up	78
26-Jul	22:30	80	M	Down	77
26-Jul	23:11	80	F	Up	78
27-Jul	0:23	80	F	Up	79
27-Jul	1:01	70	M	Up	80
27-Jul	1:18	50	M	Up	81
27-Jul	1:27	80	F	Up	82
27-Jul	16:17	80	F	Up	83
27-Jul	17:22	80	F	Up	84
27-Jul	22:00	80	M	Down	83
27-Jul	23:43	80	M	Up	84
28-Jul	0:15	70	M	Up	85
28-Jul	2:12	70	F	Down	84
28-Jul	2:12	80	M	Down	83

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement

28-Jul	4:52	90	M	Down	82
28-Jul	5:05	60	M	Up	83
28-Jul	6:00	50	M	Up	84
28-Jul	17:31	90	M	Up	85
28-Jul	18:31	80	M	Up	86
28-Jul	21:57	70	F	Up	87
28-Jul	22:43	60	M	Up	88
29-Jul	0:02	60	M	Up	89
29-Jul	1:28	50	M	Up	90
29-Jul	4:15	80	F	Down	89
29-Jul	4:20	80	F	Down	88
29-Jul	5:49	70	M	Down	87
29-Jul	6:16	80	F	Up	88
29-Jul	12:30	70	F	Down	87
29-Jul	16:36	80	M	Up	88
29-Jul	20:12	70	F	Up	89
30-Jul	0:08	80	M	Down	88
30-Jul	2:05	60	M	Up	89
30-Jul	2:07	70	M	Up	90
30-Jul	2:19	70	F	Down	89
30-Jul	2:19	80	M	Down	88
30-Jul	2:21	70	M	Up	89
30-Jul	2:42	70	F	Down	88
30-Jul	2:46	70	M	Down	87
30-Jul	2:51	80	M	Up	88
30-Jul	3:25	80	M	Down	87
30-Jul	4:31	80	M	Down	86
30-Jul	5:41	70	F	Down	85
30-Jul	5:51	80	F	Up	86
30-Jul	12:04	80	M	Up	87
30-Jul	12:08	80	M	Down	86
30-Jul	12:52	80	M	Up	87
30-Jul	13:01	70	M	Up	88
30-Jul	14:24	70	M	Down	87
30-Jul	16:48	70	F	Up	88

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
30-Jul	17:24	80	M	Up	89

30-Jul	20:31	80	M	Down	88
30-Jul	23:14	80	M	Up	89
31-Jul	0:59	60	M	Up	90
31-Jul	1:20	80	M	Down	89
31-Jul	1:30	80	F	Up	90
31-Jul	2:04	90	M	Up	91
31-Jul	2:29	50	M	Up	92
31-Jul	4:54	90	M	Down	91
31-Jul	4:55	70	M	Down	90
31-Jul	22:35	90	M	Up	91
31-Jul	23:09	50	M	Up	92
31-Jul	23:10	50	M	Up	93
31-Jul	23:16	80	M	Down	92
1-Aug	0:24	80	M	Up	93
1-Aug	0:52	80	F	Up	94
1-Aug	2:14	70	F	Down	93
1-Aug	2:15	70	F	Up	94
1-Aug	2:22	70	M	Down	93
1-Aug	2:28	50	M	Up	94
1-Aug	2:35	80	M	Up	95
1-Aug	4:36	60	M	Down	94
1-Aug	4:36	60	M	Up	95
1-Aug	4:44	80	M	Down	94
1-Aug	4:44	70	F	Down	93
1-Aug	5:15	70	M	Down	92
1-Aug	5:17	50	M	Up	93
1-Aug	5:56	80	M	Up	94
1-Aug	6:04	80	M	Down	93
1-Aug	15:00	70	M	Up	94
1-Aug	18:44	70	M	Down	93
1-Aug	20:27	80	M	Down	92
1-Aug	20:35	80	M	Up	93
1-Aug	22:20	70	M	Down	92
1-Aug	22:50	90	M	Up	93

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
1-Aug	23:51	80	M	Up	94
1-Aug	23:52	80	M	Down	93
2-Aug	0:08	80	M	Up	94

2-Aug	0:14	70	M	Up	95
2-Aug	0:21	80	M	Up	96
2-Aug	0:26	60	M	Up	97
2-Aug	0:34	60	M	Up	98
2-Aug	0:57	70	M	Down	97
2-Aug	2:12	70	F	Up	98
2-Aug	3:46	50	M	Up	99
2-Aug	20:28	80	M	Down	98
2-Aug	21:33	80	M	Down	97
2-Aug	23:28	80	M	Up	98
3-Aug	0:03	80	M	Up	99
3-Aug	0:45	50	M	Up	100
3-Aug	6:03	60	M	Up	101
3-Aug	17:54	70	M	Up	102
3-Aug	22:23	90	M	Up	103
4-Aug	0:28	70	F	Up	104
4-Aug	0:34	70	F	Down	103
4-Aug	1:57	80	F	Up	104
4-Aug	1:59	70	M	Up	105
4-Aug	2:15	50	M	Up	106
4-Aug	2:50	80	F	Down	105
4-Aug	3:29	60	M	Down	104
4-Aug	3:35	60	M	Up	105
4-Aug	4:51	70	M	Down	104
4-Aug	5:55	80	M	Up	105
4-Aug	6:43	80	F	Up	106
4-Aug	6:52	70	M	Down	105
4-Aug	6:58	70	F	Up	106
4-Aug	15:32	80	M	Down	105
4-Aug	19:33	70	F	Up	106
5-Aug	1:35	70	F	Up	107
5-Aug	1:46	80	M	Down	106

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
5-Aug	2:27	80	M	Up	107
5-Aug	14:52	80	F	Down	106
5-Aug	15:26	80	F	Down	105
5-Aug	22:25	80	M	Up	106
5-Aug	22:43	80	F	Up	107

6-Aug	0:01	70	M	Up	108
6-Aug	0:55	80	F	Up	109
6-Aug	1:10	70	M	Up	110
6-Aug	1:37	70	F	Up	111
6-Aug	2:40	70	F	Up	112
6-Aug	4:04	90	M	Up	113
6-Aug	4:16	70	M	Down	112
6-Aug	4:33	70	M	Up	113
6-Aug	5:04	80	M	Down	112
6-Aug	5:37	80	M	Up	113
6-Aug	5:42	60	M	Up	114
6-Aug	5:47	70	M	Down	113
6-Aug	6:10	60	M	Down	112
6-Aug	21:56	80	M	Down	111
7-Aug	1:10	80	M	Down	110
7-Aug	1:30	70	M	Up	111
7-Aug	1:50	80	M	Up	112
7-Aug	2:01	70	M	Up	113
7-Aug	3:07	70	M	Down	112
7-Aug	12:25	70	F	Down	111
7-Aug	16:32	80	M	Down	110
7-Aug	16:42	80	M	Up	111
7-Aug	20:54	80	M	Down	110
8-Aug	0:14	80	M	Up	111
8-Aug	0:38	80	F	Up	112
8-Aug	1:15	70	M	Up	113
8-Aug	1:56	50	M	Up	114
8-Aug	5:16	50	M	Down	113
8-Aug	6:11	70	M	Down	112
8-Aug	6:17	80	M	Up	113

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
8-Aug	7:53	70	M	Down	112
8-Aug	19:59	80	M	Down	111
8-Aug	22:57	70	M	Up	112
8-Aug	23:33	80	M	Down	111
8-Aug	23:51	80	M	Up	112
9-Aug	0:49	70	M	Up	113
9-Aug	1:34	60	M	Up	114

9-Aug	2:55	80	F	Down	113
9-Aug	2:55	80	F	Up	114
9-Aug	2:59	80	F	Down	113
9-Aug	3:09	80	M	Down	112
9-Aug	5:58	70	M	Down	111
9-Aug	6:41	90	M	Up	112
9-Aug	17:03	80	M	Up	113
9-Aug	17:30	80	M	Down	112
9-Aug	21:44	80	M	Up	113
9-Aug	23:18	70	M	Down	112
9-Aug	23:18	70	M	Up	113
9-Aug	23:46	70	M	Up	114
10-Aug	0:02	80	M	Up	115
10-Aug	1:22	50	M	Down	114
10-Aug	1:36	?	M	Down	113
10-Aug	2:23	70	M	Down	112
10-Aug	2:57	50	M	Down	111
10-Aug	3:03	80	F	Up	112
10-Aug	3:23	70	M	Up	113
10-Aug	4:11	60	M	Up	114
10-Aug	6:04	70	M	Up	114
10-Aug	7:41	80	M	Down	114
10-Aug	8:51	80	M	Down	113
10-Aug	10:46	80	M	Up	114
10-Aug	11:17	70	M	Down	113
10-Aug	12:52	80	M	Up	114
10-Aug	12:57	80	M	Down	113
10-Aug	15:00	80	M	Down	112

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
10-Aug	15:00	80	M	Up	113
10-Aug	15:01	80	M	Down	112
10-Aug	17:17	70	M	Up	113
10-Aug	17:48	80	F	Up	114
10-Aug	19:05	70	M	Up	115
10-Aug	19:10	80	M	Down	114
10-Aug	19:23	80	M	Up	115
10-Aug	21:02	80	M	Down	114
10-Aug	22:02	80	M	Down	113

10-Aug	22:16	70	M	Up	114
10-Aug	22:23	80	M	Up	115
10-Aug	23:28	80	M	Up	116
10-Aug	23:35	80	M	Down	115
11-Aug	0:09	80	M	Up	116
11-Aug	1:27	50	M	Up	117
11-Aug	1:42	90	M	Up	118
11-Aug	2:17	80	M	Up	119
11-Aug	3:06	80	F	Up	120
11-Aug	5:07	70	M	Down	119
11-Aug	5:09	80	M	Down	118
11-Aug	5:18	80	M	Up	119
11-Aug	7:20	50	M	Down	118
11-Aug	10:51	70	M	Down	117
11-Aug	12:22	70	M	Up	118
11-Aug	13:21	50	M	Down	117
11-Aug	17:27	80	M	Down	116
11-Aug	19:39	80	M	Up	117
11-Aug	21:19	80	M	Down	116
11-Aug	21:55	70	M	Down	115
11-Aug	21:55	70	M	Up	116
11-Aug	21:55	60	M	Up	117
11-Aug	22:03	60	M	Down	116
11-Aug	22:56	60	M	Up	117
11-Aug	23:09	70	M	Down	116
11-Aug	23:19	80	M	Up	117
11-Aug	23:42	80	F	Up	118

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
12-Aug	1:04	60	M	Down	117
12-Aug	1:44	70	M	Down	116
12-Aug	1:44	80	M	Up	117
12-Aug	2:03	50	M	Up	118
12-Aug	3:11	80	M	Up	119
12-Aug	3:14	80	M	Down	118
12-Aug	3:19	60	M	Down	117
12-Aug	6:58	50	M	Up	118
12-Aug	8:25	80	F	Up	119
12-Aug	8:25	50	M	Up	120
12-Aug	14:09		M	Down	119

12-Aug	14:57	50	M	Down	118
12-Aug	17:31	50	M	Up	119
12-Aug	17:42	60	M	Down	118
12-Aug	19:17	70	M	Up	119
12-Aug	19:54	50	M	Down	118
12-Aug	20:07	80	M	Down	117
12-Aug	20:07	80	M	Down	116
12-Aug	20:46	80	M	Down	115
12-Aug	21:46	70	M	Up	116
12-Aug	21:57	50	M	Up	117
12-Aug	22:01	80	M	Down	116
12-Aug	22:04	50	M	Up	117
12-Aug	22:16	70	M	Up	118
12-Aug	22:16	70	M	Down	117
12-Aug	22:26	50	M	Up	11
12-Aug	23:22	80	M	Up	119
12-Aug	23:50	80	M	Up	120
13-Aug	0:13	90	M	Up	121
13-Aug	0:25	80	M	Down	120
13-Aug	1:17	50	M	Down	119
13-Aug	1:22	60	M	Down	118
13-Aug	1:24	80	M	Up	119
13-Aug	2:04	50	M	Up	120
13-Aug	2:14	50	M	Down	119

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
13-Aug	2:37	80	F	Up	120
13-Aug	2:57	50	M	Up	121
13-Aug	3:06	80	M	Up	122
13-Aug	4:31	50	M	Up	123
13-Aug	4:41	60	M	Up	124
13-Aug	5:17	60	M	Down	123
13-Aug	6:12	50	M	Down	122
13-Aug	15:35	80	M	Down	121
13-Aug	16:48	80	M	Up	122
13-Aug	20:58	80	M	Down	121
13-Aug	20:58	90	M	Up	122
13-Aug	21:10	80	M	Down	121
13-Aug	22:19	50	M	Up	122

13-Aug	22:27	80	M	Down	121
13-Aug	22:31	50	M	Down	120
13-Aug	22:56	80	M	Up	121
13-Aug	23:29	50	M	Up	122
13-Aug	23:37	50	M	Up	123
13-Aug	23:54	60	M	Up	124
14-Aug	0:13	70	M	Up	125
14-Aug	0:21	80	M	Down	124
14-Aug	0:24	80	M	Down	123
14-Aug	0:43	80	M	Up	124
14-Aug	0:53	80	F	Up	125
14-Aug	0:53	80	M	Up	126
14-Aug	1:20	80	M	Down	125
14-Aug	2:02	70	M	Up	126
14-Aug	2:16	80	M	Down	125
14-Aug	4:43	80	M	Up	126
14-Aug	4:49	60	M	Down	125
14-Aug	5:23	50	M	Up	126
14-Aug	5:51	50	M	Up	127
14-Aug	6:12	60	M	Down	126
14-Aug	6:24	80	M	Up	127
14-Aug	7:54	90	F	Down	126

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
14-Aug	8:23	70	M	Down	125
14-Aug	19:58	50	M	Down	124
14-Aug	20:28	50	M	Up	125
14-Aug	22:47	70	M	Up	126
14-Aug	23:14	60	M	Up	127
14-Aug	23:31	70	M	Down	126
15-Aug	0:33	50	M	Down	125
15-Aug	0:46	80	M	Down	124
15-Aug	0:46	80	M	Up	125
15-Aug	0:50	80	M	Down	124
15-Aug	1:52	80	M	Up	125
15-Aug	2:04	60	M	Down	124
15-Aug	3:16	50	M	Up	125
15-Aug	3:23	50	M	Up	126
15-Aug	3:55	80	F	Up	127

15-Aug	4:57	60	M	Down	126
15-Aug	5:43	50	M	Up	127
15-Aug	6:32	80	M	Up	128
15-Aug	6:49	80	M	Down	127
15-Aug	7:01	80	M	Down	126
15-Aug	13:23	80	M	Down	125
15-Aug	13:38	70	M	Down	124
15-Aug	14:05	70	M	Up	125
15-Aug	14:11	80	M	Down	124
15-Aug	18:14	70	M	Down	123
15-Aug	18:46	80	M	Up	124
15-Aug	19:12	80	M	Up	125
15-Aug	19:21	70	M	Up	126
15-Aug	20:21	60	M	Down	125
15-Aug	20:21	50	M	Down	124
15-Aug	20:36	50	M	Up	125
15-Aug	21:13	80	M	Down	124
15-Aug	21:31	50	M	Up	125
15-Aug	21:44	80	M	Up	126
15-Aug	21:56	60	M	Down	125

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
15-Aug	22:33	80	M	Down	124
15-Aug	22:35	50	M	Down	123
15-Aug	22:48	50	M	Down	122
15-Aug	23:30	50	M	Up	123
15-Aug	23:39	50	M	Up	124
16-Aug	1:55	50	M	Up	125
16-Aug	2:29	80	F	Up	126
16-Aug	3:51	50	M	Down	125
16-Aug	5:59	50	M	Up	126
16-Aug	9:38	50	M	Down	125
16-Aug	9:43	50	M	Up	126
16-Aug	13:27		F	Down	125
16-Aug	13:27		M	Down	124
16-Aug	14:36	50	M	Down	123
16-Aug	14:46	60	M	Down	122
16-Aug	16:11	60	M	Up	123
16-Aug	16:22	60	M	Down	122

16-Aug	16:37	50	M	Up	123
16-Aug	18:04	60	M	Down	122
16-Aug	18:57	50	M	Up	123
16-Aug	20:02	80	M	Up	124
16-Aug	21:07	60	M	Down	123
16-Aug	21:19	80	M	Up	124
16-Aug	21:50	60	M	Up	125
16-Aug	22:18	60	M	Down	124
16-Aug	22:43	60	M	Down	123
16-Aug	22:56	50	M	Up	124
16-Aug	23:08	70	M	Down	123
16-Aug	23:39	50	M	Down	122
17-Aug	0:13	50	M	Up	123
17-Aug	1:26	80	M	Up	124
17-Aug	1:54	70	M	Up	125
17-Aug	2:57	50	M	Down	124
17-Aug	3:15	70	M	Down	123
17-Aug	3:23	50	M	Down	122

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
17-Aug	3:49	50	M	Down	121
17-Aug	4:00	50	M	Down	120
17-Aug	4:07	50	M	Up	121
17-Aug	4:40	50	M	Up	122
17-Aug	5:52	50	M	Up	123
17-Aug	6:12	50	M	Up	124
17-Aug	6:44	50	M	Down	123
17-Aug	6:44	80	M	Down	122
17-Aug	6:45	50	M	Up	123
17-Aug	7:13	90	M	Up	124
17-Aug	10:35	50	M	Up	125
17-Aug	13:55	60	M	Down	124
17-Aug	13:55	60	M	Up	125
17-Aug	14:03	50	M	Down	124
17-Aug	14:03	80	M	Down	123
17-Aug	15:38	50	M	Up	124
17-Aug	17:26	50	M	Up	125
17-Aug	19:38	50	M	Down	124
17-Aug	19:56	80	M	Down	123

17-Aug	20:19	50	M	Up	124
17-Aug	20:34	70	M	Up	125
17-Aug	21:12	80	M	Down	124
17-Aug	21:21	80	M	Down	123
17-Aug	21:25	80	M	Up	124
17-Aug	21:35	80	M	Down	123
17-Aug	22:41	50	M	Down	122
17-Aug	22:58	80	F	Up	123
17-Aug	23:02	50	M	Up	124
18-Aug	1:28	60	M	Down	123
18-Aug	1:31	50	M	Down	122
18-Aug	1:54	70	M	Down	121
18-Aug	3:09	80	F	Up	122
18-Aug	3:53	50	M	Down	121
18-Aug	4:28	50	M	Up	122
18-Aug	4:49	70	M	Up	123

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
18-Aug	5:06	50	M	Up	124
18-Aug	6:08	60	M	Down	123
18-Aug	7:44	50	M	Up	124
18-Aug	11:40	80	M	Down	123
18-Aug	11:41	60	M	Down	122
18-Aug	11:41	50	M	Up	123
18-Aug	11:44	50	M	Down	122
18-Aug	11:46	80	M	Down	121
18-Aug	11:49	50	M	Down	120
18-Aug	11:49	50	M	Up	121
18-Aug	11:52	50	M	Down	120
18-Aug	12:30	50	M	Up	121
18-Aug	12:51	50	M	Up	122
18-Aug	13:04	80	M	Down	121
18-Aug	14:33	50	M	Down	120
18-Aug	15:28	60	M	Down	119
18-Aug	16:46	80	M	Up	120
18-Aug	19:23	60	M	Up	121
18-Aug	20:14	60	M	Down	120
18-Aug	20:20	50	M	Down	119
18-Aug	20:20	50	M	Up	120

18-Aug	20:21	50	M	Down	119
18-Aug	20:42	50	M	Up	120
18-Aug	20:53	60	M	Up	121
18-Aug	21:42	50	M	Up	122
18-Aug	22:49	60	M	Down	121
18-Aug	23:51	90	M	Up	122
18-Aug	23:55	60	M	Up	123
19-Aug	6:11	60	M	Down	122
19-Aug	6:55	50	M	Up	123
19-Aug	7:04	80	M	Down	122
19-Aug	8:12	60	M	Down	121
19-Aug	8:16	80	M	Up	122
19-Aug	9:08	80	M	Down	121
19-Aug	9:37	50	M	Down	120

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
19-Aug	10:46	50	M	Down	119
19-Aug	11:30	50	M	Up	120
19-Aug	13:39	50	M	Up	121
19-Aug	18:28	80	M	Down	120
19-Aug	21:30	50	M	Down	119
19-Aug	22:23	50	M	Down	118
19-Aug	22:39	50	M	Up	119
20-Aug	1:33	60	M	Down	118
20-Aug	2:13	50	M	Down	117
20-Aug	3:49	50	M	Up	118
20-Aug	4:08	50	M	Up	119
20-Aug	4:18	50	M	Up	120
20-Aug	4:54	80	M	Down	119
20-Aug	4:55	80	M	Up	120
20-Aug	5:00	80	M	Down	119
20-Aug	5:02	60	M	Down	118
20-Aug	5:51	50	M	Down	118
20-Aug	6:42	90	M	Down	117
20-Aug	7:31	70	M	Up	118
20-Aug	7:45	90	M	Up	119
20-Aug	9:11	60	M	Up	120
20-Aug	12:28	50	M	Down	119
20-Aug	13:22	60	M	Down	118

20-Aug	14:42	80	M	Down	117
20-Aug	15:26	80	M	Down	116
20-Aug	15:43	80	M	Up	117
20-Aug	16:08	50	M	Up	118
20-Aug	16:39	60	M	Up	119
20-Aug	17:11	50	M	Down	118
20-Aug	18:35	60	M	Down	117
20-Aug	18:37	50	M	Down	116
20-Aug	19:47	50	M	Down	115
20-Aug	20:25	50	M	Up	116
20-Aug	20:32	50	M	Down	115
20-Aug	21:21	50	M	Down	114

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
20-Aug	22:08	50	M	Up	115
20-Aug	23:02	50	M	Down	114
21-Aug	0:03	50	M	Down	113
21-Aug	0:16	80	M	Up	114
21-Aug	0:43	60	M	Down	113
21-Aug	1:19	60	M	Up	114
21-Aug	1:35	60	M	Down	113
21-Aug	1:38	60	M	Up	114
21-Aug	2:48	50	M	Up	115
21-Aug	2:52	60	M	Down	114
21-Aug	3:02	50	M	Up	115
21-Aug	4:28	50	M	Up	116
21-Aug	6:08	60	M	Up	117
21-Aug	7:05	80	M	Down	116
21-Aug	7:17	60	M	Up	117
21-Aug	8:12	60	M	Down	116
21-Aug	8:46	60	M	Up	117
21-Aug	9:42	50	M	Up	118
21-Aug	14:10	50	M	Up	119
21-Aug	14:23	50	M	Down	118
21-Aug	19:11	50	M	Down	117
21-Aug	19:47	80	M	Down	116
21-Aug	19:49	70	M	Down	115
21-Aug	19:57	50	M	Down	114
21-Aug	20:31	80	M	Up	115

21-Aug	21:01	50	M	Up	116
21-Aug	21:22	70	M	Down	115
21-Aug	21:53	90	M	Up	116
21-Aug	22:31	80	M	Up	117
21-Aug	23:51	50	M	Down	116
22-Aug	0:08	50	M	Down	115
22-Aug	1:01	50	M	Down	114
22-Aug	2:07	60	M	Up	115
22-Aug	3:05	80	M	Down	114
22-Aug	3:27	60	M	Up	115

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
22-Aug	3:29	50	M	Down	114
22-Aug	3:39	50	M	Up	115
22-Aug	3:48	50	M	Up	116
22-Aug	4:36	80	M	Down	115
22-Aug	4:46	50	M	Down	114
22-Aug	6:17	80	M	Down	113
22-Aug	6:54	50	M	Up	114
22-Aug	6:55	50	M	Down	113
22-Aug	9:28	50	M	Down	112
22-Aug	9:35	50	M	Down	111
22-Aug	10:32	50	M	Down	110
22-Aug	13:09	50	M	Up	111
22-Aug	16:46	60	M	Up	112
22-Aug	19:06	50	M	Down	111
22-Aug	19:31	60	M	Down	110
22-Aug	20:08	80	M	Up	111
22-Aug	20:12	50	M	Down	110
22-Aug	21:12	50	M	Up	111
22-Aug	22:02	50	M	Down	110
22-Aug	22:06	50	M	Down	109
22-Aug	22:58	60	M	Up	110
22-Aug	23:31	50	M	Down	109
23-Aug	0:58	70	M	Down	108
23-Aug	2:27	70	M	Down	107
23-Aug	2:54	50	M	Up	108
23-Aug	3:27	50	M	Down	107
23-Aug	3:45	80	M	Up	108

23-Aug	3:49	50	M	Up	109
23-Aug	3:58	50	M	Down	108
23-Aug	5:33	50	M	Up	109
23-Aug	7:38	50	M	Down	108
23-Aug	8:37	60	M	Down	107
23-Aug	8:58	50	M	Up	108
23-Aug	9:01	50	M	Up	109
23-Aug	9:25	50	M	Down	108

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
23-Aug	12:44	50	M	Down	107
23-Aug	13:25	70	M	Down	106
23-Aug	14:50	60	M	Down	105
23-Aug	14:50	60	M	Down	104
23-Aug	15:58	50	M	Up	105
23-Aug	17:09	60	M	Up	106
23-Aug	17:31	50	M	Up	107
23-Aug	18:41	80	M	Up	108
23-Aug	18:53	60	M	Up	109
23-Aug	21:45	50	M	Down	108
23-Aug	22:09	60	M	Up	109
23-Aug	22:10	-	M	Up	110
24-Aug	0:12	-	M	Down	109
24-Aug	1:11	60	M	Down	108
24-Aug	1:55	60	M	Up	109
24-Aug	2:26	50	M	Up	110
24-Aug	3:06	50	M	Up	111
24-Aug	3:46	70	M	Down	110
24-Aug	3:59	60	M	Down	109
24-Aug	6:07	80	M	Up	110
24-Aug	9:06	60	M	Down	109
24-Aug	9:36	50	M	Down	108
24-Aug	12:19	50	M	Down	107
24-Aug	12:37	50	M	Down	106
24-Aug	13:55	50	M	Down	106
24-Aug	14:58	50	M	Up	107
24-Aug	15:11	50	M	Up	108
24-Aug	18:15	50	M	Down	107
24-Aug	18:17	60	M	Down	106

24-Aug	18:43	60	M	Up	107
24-Aug	19:23	70	M	Down	106
24-Aug	19:51	50	M	Up	107
24-Aug	20:09	50	M	Up	108
24-Aug	20:31	70	M	Up	109
24-Aug	21:20	50	M	Up	110

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
24-Aug	21:38	70	M	Down	109
24-Aug	21:54	80	M	Down	108
24-Aug	22:01	50	M	Up	109
24-Aug	22:04	50	M	Up	110
24-Aug	23:33	90	M	Down	109
25-Aug	0:08	60	M	Down	108
25-Aug	1:37	60	M	Up	109
25-Aug	1:56	50	M	Up	110
25-Aug	3:26	50	M	Up	111
25-Aug	3:31	70	M	Down	110
25-Aug	4:52	-	-	Down	109
25-Aug	4:54	50	M	Down	108
25-Aug	4:55	50	M	Up	109
25-Aug	4:56	50	M	Down	108
25-Aug	6:24	50	M	Down	107
25-Aug	6:50	90	M	Up	108
25-Aug	9:08	50	M	Down	107
25-Aug	9:17	60	M	Up	108
25-Aug	9:50	50	M	Down	107
25-Aug	10:48	50	M	Up	108
25-Aug	11:39	80	M	Down	107
25-Aug	11:50	80	M	Up	108
25-Aug	13:45	50	M	Down	107
25-Aug	14:12	60	M	Up	108
25-Aug	16:41	60	M	Up	109
25-Aug	16:41	60	M	Up	110
25-Aug	18:24	60	M	Up	111
25-Aug	18:31	80	M	Down	110
25-Aug	18:35	50	M	Down	109
25-Aug	20:25	60	M	Up	110
25-Aug	20:46	50	M	Down	109

25-Aug	22:20	50	M	Up	110
25-Aug	23:21	-	M	Down	109
25-Aug	23:52	50	M	Down	108
25-Aug	23:53	50	M	Down	107

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
26-Aug	0:19	60	M	Up	108
26-Aug	0:39	70	M	Up	109
26-Aug	3:14	70	M	Down	108
26-Aug	3:21	50	M	Down	107
26-Aug	9:04	70	M	Down	106
26-Aug	9:53	70	M	Down	105
26-Aug	11:56	60	M	Down	104
26-Aug	15:36	50	M	Down	103
26-Aug	15:39	50	M	Up	104
26-Aug	16:37	50	M	Down	103
26-Aug	18:39	70	M	Up	104
26-Aug	20:50	50	M	Up	105
26-Aug	21:02	70	M	Up	106
26-Aug	22:39	50	M	Up	107
26-Aug	22:58	50	M	Up	108
27-Aug	1:31	50	M	Up	109
27-Aug	4:25	70	M	Down	108
27-Aug	5:35	60	M	Down	107
27-Aug	8:39	60	M	Up	108
27-Aug	12:13	60	M	Down	107
27-Aug	14:08	60	M	Up	108
27-Aug	16:24	70	M	Down	107
27-Aug	17:35	50	M	Down	106
27-Aug	19:20	90	M	Down	105
27-Aug	19:30	90	M	Up	106
27-Aug	22:43	80	M	Up	107
27-Aug	22:59	50	M	Up	108
28-Aug	0:03	70	M	Up	109
28-Aug	0:42	50	M	Up	110
28-Aug	1:38	60	M	Down	109
28-Aug	7:45	60	M	Down	108
28-Aug	8:23	60	M	Up	109
28-Aug	11:59	50	M	Down	108

28-Aug	17:25	60	M	Up	109
28-Aug	18:16	80	M	Down	108

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
28-Aug	18:27	60	M	Down	107
28-Aug	20:28	80	M	Up	108
29-Aug	2:21	70	M	Down	107
29-Aug	4:59	80	M	Down	106
29-Aug	5:23	70	M	Down	105
29-Aug	8:18	80	M	Down	104
29-Aug	8:34	90	M	Down	103
29-Aug	10:07	80	M	Up	104
29-Aug	13:47	60	M	Up	105
29-Aug	13:50	80	M	Up	106
29-Aug	14:15	50	M	Up	107
29-Aug	14:32	90	M	Up	108
29-Aug	19:49	50	M	Up	109
29-Aug	22:56	80	M	Down	108
30-Aug	2:29	50	M	Down	107
30-Aug	2:34	60	M	Down	106
30-Aug	2:53	80	M	Up	107
30-Aug	3:28	50	M	Up	108
30-Aug	3:35	60	M	Down	107
30-Aug	4:15	50	M	Down	106
30-Aug	4:30	50	M	Up	107
30-Aug	4:52	50	M	Down	106
30-Aug	5:12	50	M	Down	105
30-Aug	5:17	70	M	Down	104
30-Aug	6:14	50	M	Down	103
30-Aug	18:19	80	M	Down	102
30-Aug	21:00	70	M	Up	103
31-Aug	0:57	50	M	Down	102
31-Aug	5:04	80	M	Up	103
31-Aug	13:03	80	M	Down	102
31-Aug	22:45	60	M	Down	101
31-Aug	23:58	50	M	Down	100
1-Sep	1:16	80	M	Down	99
1-Sep	2:39	60	M	Up	100
1-Sep	5:10	80	M	Up	101

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
1-Sep	14:59	60	M	Up	102
2-Sep	16:12	60	M	Down	101
2-Sep	18:43	50	M	Up	102
2-Sep	22:54	50	M	Down	101
3-Sep	0:12	50	M	Down	100
3-Sep	0:41	50	M	Up	101
3-Sep	5:11	90	M	Up	102
3-Sep	19:31	50	M	Down	101
3-Sep	21:43	80	M	Down	100
3-Sep	21:43	80	M	Up	101
3-Sep	21:46	80	M	Down	100
3-Sep	22:24	80	M	Down	99
4-Sep	3:15	60	M	Down	98
4-Sep	16:36	60	M	Down	97
4-Sep	17:15	60	M	Up	98
4-Sep	17:22	60	M	Down	97
4-Sep	20:26	60	M	Down	96
4-Sep	21:51	70	M	Up	97
4-Sep	23:21	80	M	Down	96
5-Sep	2:04	60	M	Up	97
5-Sep	5:39	80	M	Up	98
6-Sep	0:41	70	M	Down	97
6-Sep	1:48	80	M	Up	98
6-Sep	18:23	70	M	Down	97
6-Sep	19:05	80	M	Up	98
6-Sep	22:59	50	M	Down	97
7-Sep	6:19	70	M	Down	96
7-Sep	6:19	70	M	Up	97
7-Sep	14:15	70	M	Down	96
7-Sep	17:38	50	M	Up	97
8-Sep	1:05	80	M	Down	96
10-Sep	23:04	60	M	Down	95
10-Sep	3:14	60	M	Up	96
11-Sep	-	-	-	-	96
12-Sep	-	-	-	-	96

Table A-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (Up/Down)	Net Upstream Movement
13-Sep	-	-	-	-	96
14-Sep	-	-	-	-	96
15-Sep	-	-	-	-	96
16-Sep	-	-	-	-	96
17-Sep	-	-	-	-	96
18-Sep	-	-	-	-	96

Table A-2. Diel movements of adult spring and summer chinook salmon through the Secesh River fish counting station, by hour, in 1999.

Time (hours)	Total Movements (up and down)	Percent (%) Total Movements	Net Upstream Movements	Percent (%) Net Upstream Movements)
0:00	69	8	33	35
1:00	57	7	13	14
2:00	59	7	5	5
3:00	49	6	3	3
4:00	49	6	-5	-5
5:00	43	5	3	3
6:00	39	5	1	1
7:00	16	2	-2	-2
8:00	14	2	0	0
9:00	17	2	-7	-7
10:00	9	1	1	1
11:00	15	2	-7	-7
12:00	16	2	-2	-2
13:00	19	2	-5	-5
14:00	25	3	-5	-5
15:00	18	2	0	0
16:00	22	3	10	10
17:00	26	3	14	14
18:00	25	3	-3	-3
19:00	32	4	0	0
20:00	41	5	7	7
21:00	45	5	5	5
22:00	71	8	17	18
23:00	61	7	19	20

Time – military time (hours)

APPENDIX B

Table B-1. Run timing and direction of adult spring and summer chinook salmon passing the escapement monitoring fish counting station in Lake Creek in 1999.

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
9-Jul	-	-	-	-	-
10-Jul	-	-	-	-	-
11-Jul	13:41	80	M	Up	1
12-Jul	3:56	80	M	Up	2
12-Jul	7:05	90	M	Up	3
13-Jul	19:41	80	F	Up	4
13-Jul	22:51	80	M	Up	5
14-Jul	11:53	90	M	Up	6
14-Jul	15:11	80	F	Up	7
14-Jul	15:11	80	M	Up	8
14-Jul	15:14	80	M	Down	7
16-Jul	18:27	80	M	Up	8
16-Jul	18:51	80	F	Up	9
16-Jul	18:51	80	F	Up	10
17-Jul	1:52	70	F	Up	11
17-Jul	4:23	70	F	Down	10
17-Jul	4:28	70	F	Up	11
17-Jul	4:42	70	F	Down	10
17-Jul	23:24	80	F	Up	11
18-Jul	2:08	80	M	Up	12
18-Jul	2:45	80	F	Down	11
18-Jul	13:59	50	M	Up	12
18-Jul	16:38	50	M	Up	13
18-Jul	17:18	50	M	Down	12
18-Jul	18:00	60	M	Down	11
18-Jul	18:56	80	M	Up	12
18-Jul	21:46	50	M	Up	13
18-Jul	23:26	80	M	Up	14
18-Jul	23:41	80	F	Up	15

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
19-Jul	0:06	50	M	Up	16
19-Jul	1:09	80	M	Up	17
19-Jul	4:34	70	F	Up	18
19-Jul	6:23	70	M	Up	19
19-Jul	16:04	80	F	Up	20
19-Jul	16:08	80	F	Up	21
19-Jul	17:13	80	F	Down	20
19-Jul	17:14	80	F	Up	21
20-Jul	0:05	60	M	Up	22
20-Jul	8:19	80	M	Up	23
20-Jul	14:14	70	M	Up	24
20-Jul	14:14	50	M	Up	25
20-Jul	14:18	50	M	Down	24
20-Jul	16:01	50	M	Up	25
20-Jul	16:05	50	M	Up	26
20-Jul	16:17	60	M	Up	27
20-Jul	16:19	50	M	Up	28
20-Jul	16:33	50	M	Down	27
20-Jul	16:34	50	M	Up	28
20-Jul	17:03	80	F	Up	29
20-Jul	17:14	80	F	Up	30
20-Jul	23:38	50	M	Up	31
21-Jul	3:02	80	M	Up	32
21-Jul	4:13	80	M	Down	31
21-Jul	7:20	80	F	Up	32
21-Jul	13:20	80	M	Up	33
22-Jul	2:01	70	M	Up	34
22-Jul	22:28	50	M	Up	35
22-Jul	22:35	70	M	Up	36
22-Jul	23:38	90	F	Up	37
23-Jul	0:08	80	F	Up	38
23-Jul	21:54	80	M	Up	39
23-Jul	10:48	50	M	Up	40

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
23-Jul	23:18		M	Up	41
24-Jul	7:57	80	F	Up	42
24-Jul	18:24	70	F	Up	43
24-Jul	18:57	80	F	Up	44
24-Jul	18:57	70	M	Up	45
25-Jul	1:39	50	M	Up	46
25-Jul	1:47	80	F	Up	47
25-Jul	22:36	50	M	Up	48
25-Jul	23:32	50	M	Up	49
26-Jul	0:48	70	F	Up	50
26-Jul	4:17	70	M	Down	49
26-Jul	4:19	70	F	Up	50
26-Jul	4:27	70	M	Down	49
26-Jul	6:11	70	M	Down	48
26-Jul	16:46	70	M	Up	49
26-Jul	18:05	80	M	Up	50
26-Jul	18:07	80	M	Up	51
26-Jul	18:19		M	Down	50
26-Jul	23:28	70	M	Up	51
27-Jul	0:34	50	M	Up	52
27-Jul	5:43	50	M	Down	51
27-Jul	21:22	60	M	Up	52
27-Jul	22:33	80	M	Up	53
28-Jul	0:13	50	M	Up	54
28-Jul	23:21	50	M	Up	55
29-Jul	0:22	70	M	Down	54
29-Jul	0:23	50	M	Up	55
29-Jul	0:23	70	M	Up	56
29-Jul	0:36	70	M	Down	55
29-Jul	0:45	70	M	Up	56
29-Jul	1:32	50	M	Up	57
29-Jul	5:30	50	M	Down	56
29-Jul	22:30	70	M	Down	55

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
29-Jul	23:23	70	M	Down	54
30-Jul	1:47	50	M	Down	53
30-Jul	4:06	80	F	Up	54
30-Jul	22:52	80	M	Up	55
31-Jul	0:18	50	M	Up	56
31-Jul	0:33	80	M	Up	57
31-Jul	23:40	70	M	Down	56
1-Aug	5:24	70	M	Up	57
1-Aug	10:51	70	M	Down	56
1-Aug	23:25	50	M	Up	57
2-Aug	6:09	80	M	Up	58
2-Aug	20:51	80	M	Down	57
2-Aug	23:03	70	M	Down	56
3-Aug	19:19	80	M	Up	57
3-Aug	23:45	50	M	Up	58
4-Aug	0:41	50	M	Down	57
4-Aug	0:43	50	M	Up	58
4-Aug	0:51	50	M	Down	57
4-Aug	2:22	50	M	Up	58
4-Aug	3:46	50	M	Up	59
4-Aug	16:34	70	M	Down	58
4-Aug	16:47	70	M	Up	59
4-Aug	16:55	70	M	Down	58
5-Aug	2:59	80	M	Down	57
5-Aug	3:22	40	M	Up	58
5-Aug	14:28	70	M	Up	59
5-Aug	21:20	70	M	Up	60
6-Aug	3:27	50	M	Up	61
6-Aug	3:33	70	M	Up	62
6-Aug	6:43	80	M	Down	61
6-Aug	16:20	50	M	Down	60
7-Aug	1:43	70	M	Up	61
7-Aug	5:07	50	M	Up	62

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
7-Aug	6:41	80	M	Down	61
7-Aug	8:36	80	F	Up	62
8-Aug	2:28	60	M	Up	63
8-Aug	3:18	50	M	Up	64
8-Aug	5:33	50	M	Down	63
8-Aug	5:36	50	M	Up	64
8-Aug	5:39	50	M	Down	63
8-Aug	10:33	50	M	Up	64
8-Aug	14:51	80	M	Up	65
8-Aug	19:16	50	M	Down	64
8-Aug	19:18	50	M	Up	65
8-Aug	19:21	50	M	Down	64
8-Aug	23:19	50	M	Down	63
8-Aug	23:24	50	M	Up	64
8-Aug	23:32	50	M	Down	63
9-Aug	0:05	50	M	Up	64
9-Aug	0:54	50	M	Down	63
9-Aug	1:14	50	M	Down	62
9-Aug	3:03	50	M	Down	61
9-Aug	4:25	50	M	Down	60
10-Aug	16:10	70	F	Down	59
11-Aug	1:42	70	M	Down	58
11-Aug	1:55	70	M	Up	59
11-Aug	2:16	70	M	Down	58
11-Aug	2:19	70	M	Up	59
11-Aug	2:22	70	M	Down	58
11-Aug	3:27	50	M	Up	59
11-Aug	4:00	50	M	Down	58
11-Aug	14:55	50	M	Down	57
11-Aug	15:00	80	M	Down	56
11-Aug	15:00	80	M	Up	57
11-Aug	15:04	80	M	Down	56
11-Aug	18:57	70	M	Down	55

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
11-Aug	20:49	50	M	Down	54
12-Aug	3:00	50	M	Up	55
12-Aug	4:16	60	M	Up	56
12-Aug	6:07	50	M	Up	57
12-Aug	6:47	50	M	Down	56
12-Aug	10:45	70	M	Up	57
12-Aug	14:34	70	M	Down	56
12-Aug	21:37	50	M	Up	57
12-Aug	21:43	50	M	Down	56
12-Aug	22:51	80	M	Down	55
12-Aug	22:59	50	M	Down	54
14-Aug	17:57	50	M	Down	53
14-Aug	18:06	80	F	Down	52
14-Aug	18:09	50	M	Down	51
14-Aug	20:36	80	M	Down	50
14-Aug	21:54	50	M	Down	49
14-Aug	23:53	50	M	Up	50
15-Aug	3:47	50	M	Down	49
15-Aug	10:37	50	M	Down	48
15-Aug	10:37	60	M	Up	49
15-Aug	10:42	60	M	Down	48
15-Aug	18:07	50	M	Up	49
15-Aug	18:55	50	M	Down	48
15-Aug	20:52	70	F	Up	49
15-Aug	20:54	70	F	Down	48
15-Aug	20:56	70	F	Up	49
15-Aug	23:14	70	M	Down	48
16-Aug	1:39	50	M	Down	47
16-Aug	3:18	50	M	Down	46
16-Aug	11:11	50	M	Down	45
16-Aug	11:18	60	M	Up	46
16-Aug	11:36	50	M	Down	45
16-Aug	14:05	50	M	Down	44

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
16-Aug	20:10	50	M	Up	45
16-Aug	20:21	70	M	Up	46
16-Aug	20:40	70	M	Down	45
16-Aug	21:18	50	M	Up	46
16-Aug	21:31	50	M	Down	45
16-Aug	22:40	50	M	Up	46
17-Aug	0:05	50	M	Up	47
17-Aug	0:06	50	M	Down	46
17-Aug	0:10	50	M	Up	47
17-Aug	1:52	50	M	Down	46
17-Aug	2:48	50	M	Down	45
17-Aug	13:55	50	M	Up	46
17-Aug	18:01	60	M	Up	47
17-Aug	18:05	60	M	Down	46
17-Aug	18:08	60	M	Up	47
17-Aug	19:36	70	F	Up	48
18-Aug	0:05	80	M	Down	47
18-Aug	3:25	50	M	Up	48
18-Aug	4:12	50	M	Down	47
18-Aug	12:52	50	M	Up	48
18-Aug	13:43	50	M	Down	47
18-Aug	13:50	50	M	Down	46
18-Aug	15:40	60	M	Down	45
18-Aug	18:38	50	M	Up	46
18-Aug	21:47	50	M	Down	45
18-Aug	21:48	60	M	Up	46
18-Aug	21:54	60	M	Down	45
18-Aug	21:56	60	M	Up	46
18-Aug	22:04	60	M	Down	45
18-Aug	22:39	50	M	Up	46
19-Aug	1:48	70	M	Up	47
19-Aug	2:02		M	Down	46
19-Aug	2:03	50	M	Down	45

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
19-Aug	2:05	70	M	Up	46
19-Aug	2:05		M	Down	45
19-Aug	14:57	60	M	Up	46
19-Aug	16:19	50	M	Up	47
19-Aug	20:51	50	M	Up	48
20-Aug	0:46	50	M	Up	49
20-Aug	0:58	50	M	Up	50
20-Aug	1:19	60	M	Up	51
20-Aug	1:52	50	M	Up	52
20-Aug	2:14	70	M	Up	53
20-Aug	2:19	70	M	Down	52
20-Aug	2:38	50	M	Up	53
20-Aug	5:14	80	M	Up	54
20-Aug	5:20	80	M	Down	53
20-Aug	5:27	80	M	Up	54
20-Aug	6:06	50	M	Up	55
20-Aug	6:31	70	M	Down	54
20-Aug	8:33	50	M	Down	53
20-Aug	9:40	50	M	Down	52
20-Aug	10:06	60	M	Up	53
20-Aug	11:17	50	M	Up	54
20-Aug	12:27	50	M	Up	55
20-Aug	12:39	50	M	Down	54
20-Aug	12:47	60	M	Down	53
20-Aug	14:06	50	M	Down	52
20-Aug	14:12	50	M	Down	51
20-Aug	15:19	60	M	Down	50
20-Aug	15:36	50	M	Down	49
20-Aug	15:56	60	M	Down	48
20-Aug	15:59	50	M	Up	49
20-Aug	16:01	50	M	Down	48
20-Aug	16:02	50	M	Up	49
20-Aug	16:02	50	M	Up	50

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
20-Aug	16:13	50	M	Down	49
20-Aug	16:18	50	M	Down	48
20-Aug	16:29	50	M	Up	49
20-Aug	16:52	50	M	Up	50
20-Aug	16:56	50	M	Up	51
20-Aug	18:50	50	M	Down	50
21-Aug	12:58	50	M	Up	51
21-Aug	13:07	50	M	Down	50
21-Aug	13:49	50	M	Down	49
21-Aug	14:58	50	M	Down	48
21-Aug	16:57	50	M	Up	49
21-Aug	20:00	50	M	Down	48
21-Aug	20:35	50	M	Up	49
21-Aug	22:55	50	M	Up	50
22-Aug	3:20	50	M	Down	49
22-Aug	12:22	50	M	Up	50
22-Aug	13:13	50	M	Down	49
22-Aug	20:19	50	M	Down	48
22-Aug	20:51	80	M	Up	49
22-Aug	23:14	50	M	Up	50
22-Aug	23:54	80	M	Down	49
23-Aug	0:01	80	M	Up	50
23-Aug	0:05	80	M	Down	49
23-Aug	5:38	50	M	Up	50
23-Aug	13:43	50	M	Up	51
23-Aug	13:59	50	M	Down	50
23-Aug	14:01	50	M	Up	51
23-Aug	14:03	50	M	Down	50
23-Aug	14:05	50	M	Up	51
23-Aug	15:24	50	M	Down	50
23-Aug	15:29	50	M	Down	49
23-Aug	17:34	50	M	Up	50
23-Aug	17:38	50	M	Up	51

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
23-Aug	17:43	50	M	Up	52
23-Aug	17:55	50	M	Up	53
23-Aug	17:55	80	M	Up	54
23-Aug	18:29	50	M	Up	55
23-Aug	18:54	50	M	Up	56
23-Aug	18:55	50	M	Down	55
23-Aug	18:58	60	M	Up	56
23-Aug	19:21	80	M	Down	55
23-Aug	19:47	50	M	Down	54
23-Aug	19:55	50	M	Down	53
23-Aug	20:53	50	M	Down	52
23-Aug	20:59	50	M	Down	51
23-Aug	21:31	50	M	Down	50
23-Aug	21:41	60	M	Down	49
24-Aug	0:50	50	M	Down	48
24-Aug	2:25	50	M	Down	47
24-Aug	2:50	50	M	Up	48
24-Aug	3:41	80	M	Up	49
24-Aug	4:05	80	M	Up	50
24-Aug	6:26	80	M	Down	49
24-Aug	13:30	50	M	Up	50
24-Aug	14:54	50	M	Up	51
24-Aug	14:54	50	M	Up	52
24-Aug	15:15	80	M	Up	53
24-Aug	16:58	80	M	Down	52
24-Aug	17:09	50	M	Down	51
24-Aug	17:16	50	M	Up	52
24-Aug	18:18	50	M	Down	51
24-Aug	18:27	50	M	Down	50
24-Aug	18:36	50	M	Up	51
24-Aug	18:46	50	M	Down	50
24-Aug	19:21	80	M	Down	49
24-Aug	19:48	50	M	Down	48

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
24-Aug	19:48	50	M	Up	49
24-Aug	19:53	50	M	Down	48
24-Aug	20:26	50	M	Down	47
24-Aug	22:25	50	M	Down	46
25-Aug	1:31	50	M	Up	47
25-Aug	1:54	50	M	Down	46
25-Aug	2:34	50	M	Up	47
25-Aug	3:33	50	M	Down	46
25-Aug	5:17	50	M	Up	47
25-Aug	13:23	50	M	Up	48
25-Aug	14:26	50	M	Up	49
25-Aug	17:18	50	M	Up	50
25-Aug	17:18	50	M	Up	51
25-Aug	17:19	50	M	Down	50
25-Aug	17:21	50	M	Up	51
25-Aug	19:56	50	M	Down	50
25-Aug	23:53	80	M	Up	51
26-Aug	2:19	50	M	Down	50
26-Aug	2:56	70	M	Down	49
26-Aug	3:16	50	M	Down	48
26-Aug	4:59	50	M	Up	49
26-Aug	14:57	50	M	Up	50
26-Aug	14:58	50	M	Down	49
26-Aug	14:58	50	M	Down	48
26-Aug	15:02	50	M	Up	49
26-Aug	15:02	50	M	Up	50
26-Aug	16:36	50	M	Down	49
26-Aug	16:38	50	M	Up	50
26-Aug	16:42	50	M	Down	49
26-Aug	16:48	50	M	Up	50
26-Aug	17:34	50	M	Down	49
26-Aug	17:36	50	M	Up	50
26-Aug	17:46	50	M	Down	49

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
26-Aug	17:48	50	M	Up	50
26-Aug	17:54	50	M	Down	49
26-Aug	17:57	50	M	Up	50
26-Aug	18:22	50	M	Down	49
26-Aug	18:22	50	M	Up	50
26-Aug	18:43	50	M	Down	49
26-Aug	19:07	50	M	Down	48
26-Aug	19:12	50	M	Up	49
26-Aug	19:17	50	M	Down	48
27-Aug	0:04	50	M	Up	49
27-Aug	2:41	50	M	Down	48
27-Aug	3:24	80	M	Up	49
27-Aug	3:36	60	M	Up	50
27-Aug	4:22	50	M	Down	49
27-Aug	7:53	50	M	Up	50
27-Aug	9:11	50	M	Down	49
27-Aug	10:12	50	M	Up	50
27-Aug	10:15	60	M	Up	51
27-Aug	11:32	50	M	Up	52
27-Aug	14:35	80	M	Down	51
27-Aug	17:08	60	M	Down	50
27-Aug	18:13	60	M	Down	49
27-Aug	21:41	50	M	Down	48
28-Aug	0:22	80	M	Up	49
28-Aug	2:10	50	M	Up	50
28-Aug	7:22	50	M	Down	49
28-Aug	8:19	50	M	Down	48
28-Aug	11:36	50	M	Up	49
28-Aug	15:19	60	M	Up	50
28-Aug	15:20	60	M	Down	49
28-Aug	15:36	60	M	Up	50
28-Aug	16:12	50	M	Up	51
28-Aug	17:26	50	M	Up	52

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
28-Aug	17:28	50	M	Down	51
28-Aug	17:54	50	M	Up	52
28-Aug	18:10	80	M	Down	51
28-Aug	23:46	50	M	Up	52
29-Aug	1:27	60	M	Down	51
29-Aug	1:49	60	M	Up	52
29-Aug	1:50	60	M	Down	51
29-Aug	3:08	50	M	Down	50
29-Aug	8:16	60	M	Up	51
29-Aug	20:58	50	M	Down	50
30-Aug	17:06	50	M	Up	51
30-Aug	17:07	50	M	Down	50
30-Aug	23:48	50	M	Up	51
31-Aug	0:01	50	M	Up	52
31-Aug	11:24	50	M	Down	51
31-Aug	11:29	50	M	Up	52
31-Aug	12:22	50	M	Down	51
31-Aug	12:25	50	M	Up	52
31-Aug	12:27	50	M	Up	53
31-Aug	12:32	50	M	Down	52
31-Aug	12:42	60	M	Down	51
31-Aug	13:44	50	M	Up	52
31-Aug	14:46	60	M	Down	51
31-Aug	21:14	50	M	Down	50
31-Aug	21:22	50	M	Up	51
31-Aug	21:28	50	M	Down	50
3-Sep	4:50	60	M	Up	51
3-Sep	20:48	60	M	Down	50
4-Sep	-	-	-	-	50
5-Sep	-	-	-	-	50
6-Sep	-	-	-	-	50
7-Sep	-	-	-	-	50
8-Sep	-	-	-	-	50

Table B-1 (continued).

Date (1999)	Time (hours)	Length (cm)	Estimated Sex (M/F)	Direction (up/down)	Net Upstream Movement
9-Sep	-	-	-	-	50
10-Sep	-	-	-	-	50
11-Sep	-	-	-	-	50
12-Sep	-	-	-	-	50
13-Sep	-	-	-	-	50

Table B-2. Diel movements of adult spring and summer chinook salmon passing through the Lake Creek fish counting station, by hour, in 1999.

Time (hours	Total Movements (Up and Down)	Percent (%) Total Movements	Net Upstream Movements	Percent (%) Net Upstream Movements
0:00	30	7	12	24
1:00	20	5	4	8
2:00	24	6	-2	-4
3:00	20	5	6	12
4:00	17	4	-1	-2
5:00	12	3	2	4
6:00	10	2	-2	-4
7:00	5	1	3	6
8:00	5	1	1	2
9:00	2	0	-2	-4
10:00	10	2	4	8
11:00	9	2	3	6
12:00	11	3	1	2
13:00	14	3	2	4
14:00	23	6	-1	-2
15:00	19	5	-1	-2
16:00	31	7	9	18
17:00	29	7	7	14
18:00	34	8	2	4
19:00	17	4	-5	-10
20:00	19	5	-5	-10
21:00	19	5	-1	-2
22:00	14	3	4	8
23:00	24	6	10	20

Time – Military time (hours)

APPENDIX C

Table C-1. Dates of net upstream migration and total movements of adult spring and summer chinook salmon through the Secesh River and Lake Creek fish counting stations in 1999.

	Lake Creek		Secesh River	
Date	Net Upstream	Total Movements	Net Upstream	Total Movements
9-Jul	0	0		
10-Jul	0	0		
11-Jul	1	1		
12-Jul	2	2		
13-Jul	2	2		
14-Jul	2	4		
15-Jul	2*	5*	Operation Began	Operation Began
16-Jul	3	3	5	5
17-Jul	1	5	12	16
18-Jul	4	10	5*	n/a
19-Jul	6	8	5	5
20-Jul	10	14	15	17
21-Jul	2	4	3	7
22-Jul	4	4	6	8
23-Jul	4	4	6	14
24-Jul	4	4	13	17
25-Jul	4	4	7	19
26-Jul	2	10	2	4
27-Jul	2	4	4	14
28-Jul	2	2	6	8
29-Jul	-1	9	4	10
30-Jul	1	3	1	9
31-Jul	1	3	0	22
1-Aug	1	3	3	11
2-Aug	-1	3	1	23
3-Aug	2	2	5	11
4-Aug	0	8	5	5
5-Aug	2	4	3	15

Table C-1 (continued).

Date	Lake Creek		Secesh River	
	Net Upstream	Total Movements	Net Upstream	Total Movements
6-Aug	0	4	1	7
7-Aug	2	4	4	14
8-Aug	1	13	-1	9
9-Aug	-3	5	2	12
10-Aug	-1	1	2	14
11-Aug	-5	13	1	29
12-Aug	0	10	3	23
13-Aug	-4	6	2	28
14-Aug	-2	10	4	26
15-Aug	-2	12	2	22
16-Aug	2	10	-2	34
17-Aug	-2	14	-2	24
18-Aug	2	8	2	34
19-Aug	2	34	-2	34
20-Aug	0	8	-4	14
21-Aug	-1	7	-5	31
22-Aug	0	26	2	28
23-Aug	-3	23	-7	27
24-Aug	5	13	1	25
25-Aug	-3	25	-1	27
26-Aug	0	14	-2	30
27-Aug	4	14	1	15
28-Aug	-2	6	0	12
29-Aug	1	3	0	10
30-Aug	-1	13	0	12
31-Aug	0	0	-5	13
1-Sep	0	0	-3	5
2-Sep	0	0	2	4
3-Sep	0	2	-1	3
4-Sep	0	0	-2	8
5-Sep	0	0	-3	7
6-Sep	0	0	2	2
7-Sep	0	0	-1	5

Table C-1 (continued).

Date	Lake Creek Net Upstream	Lake Creek Total Movements	Secesh River Net Upstream	Secesh River Total Movements
8-Sep	0	0	0	4
9-Sep	0	0	1	1
10-Sep	0	0	-1	1
11-Sep	0	0	1	1
12-Sep	0	0	0	0
13-Sep	0	0	0	0
14-Sep	Operation Ceased	Operation Ceased	0	0
15-Sep			0	0
16-Sep			0	0
17-Sep			0	0
18-Sep			0	0
			Operation Ceased	Operation Ceased

*Estimate during equipment outage